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THE ELECTRICAL REVIEW

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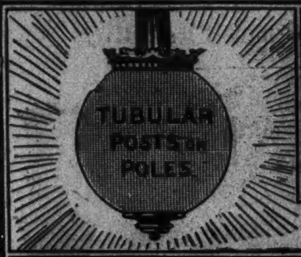

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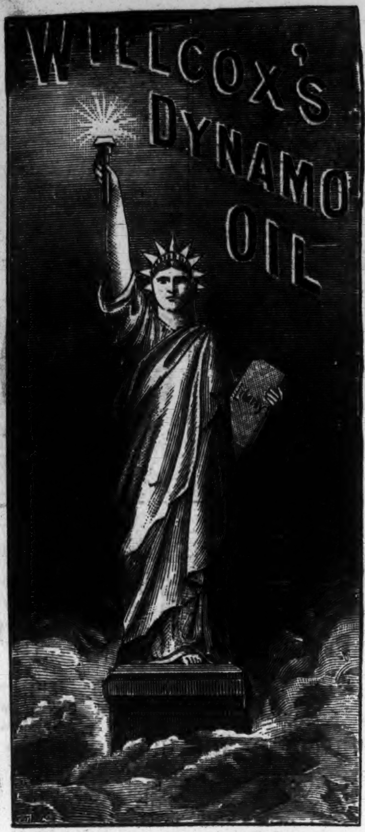

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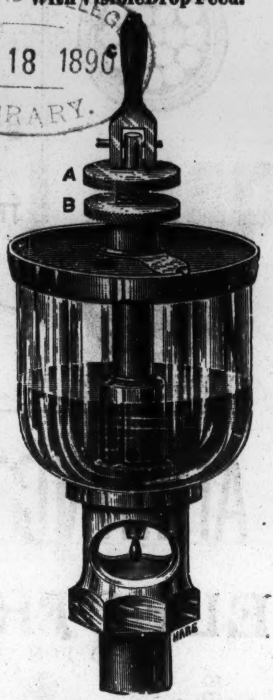

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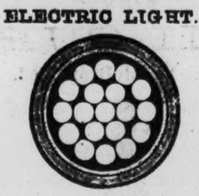

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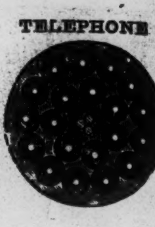

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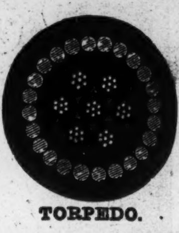

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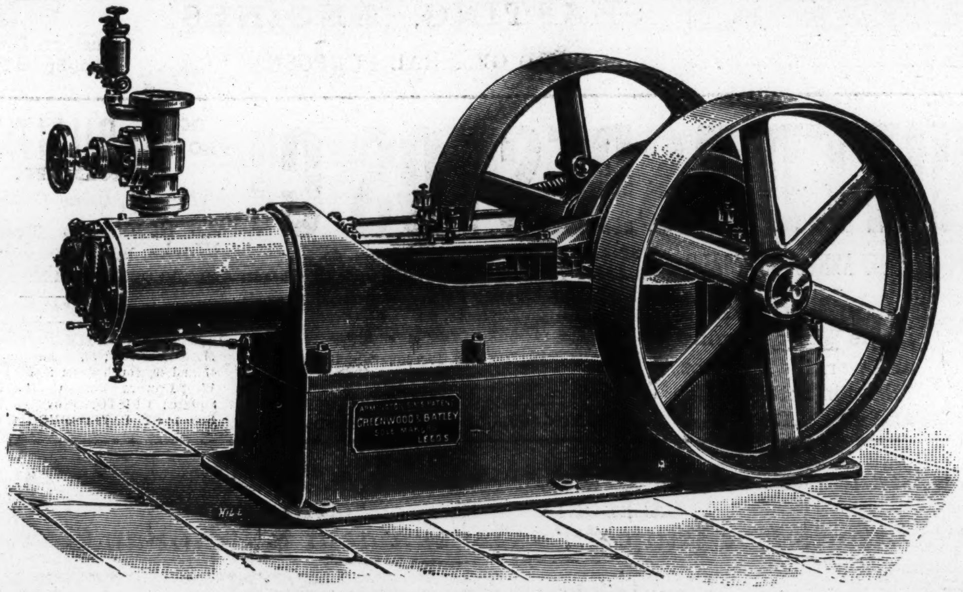

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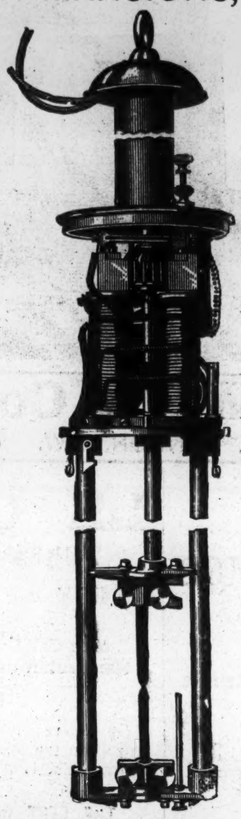

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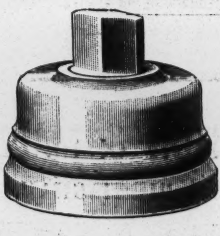

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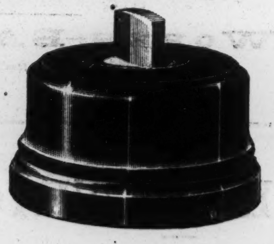

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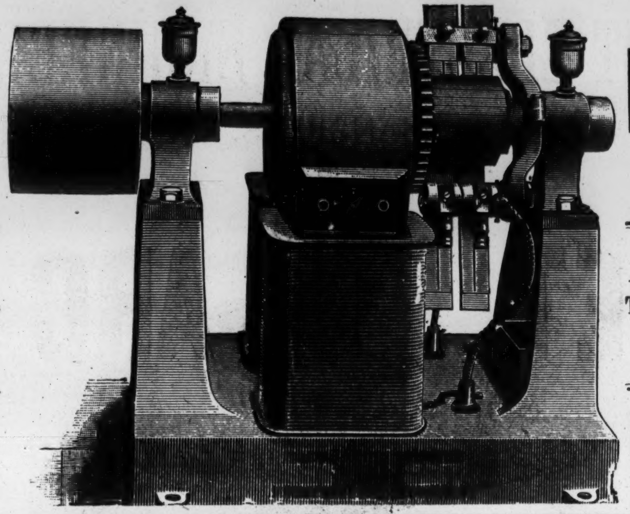

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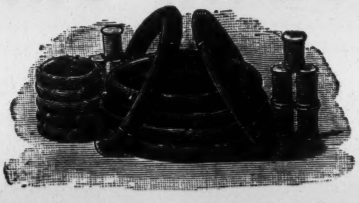

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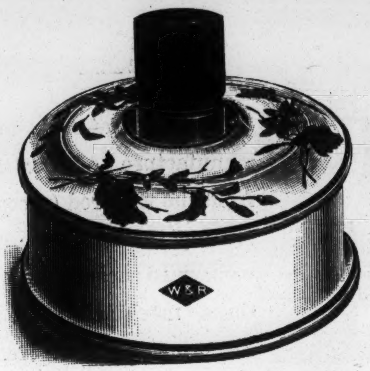

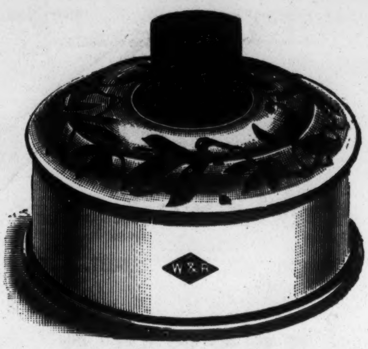

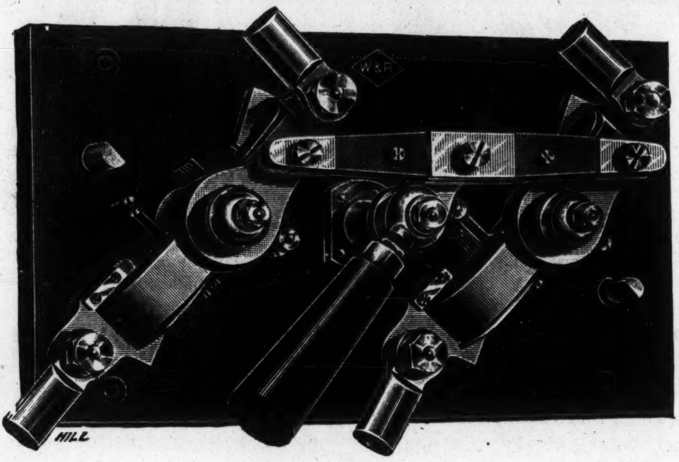

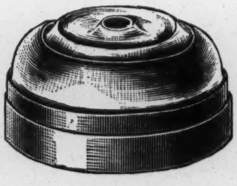

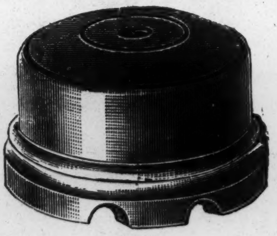

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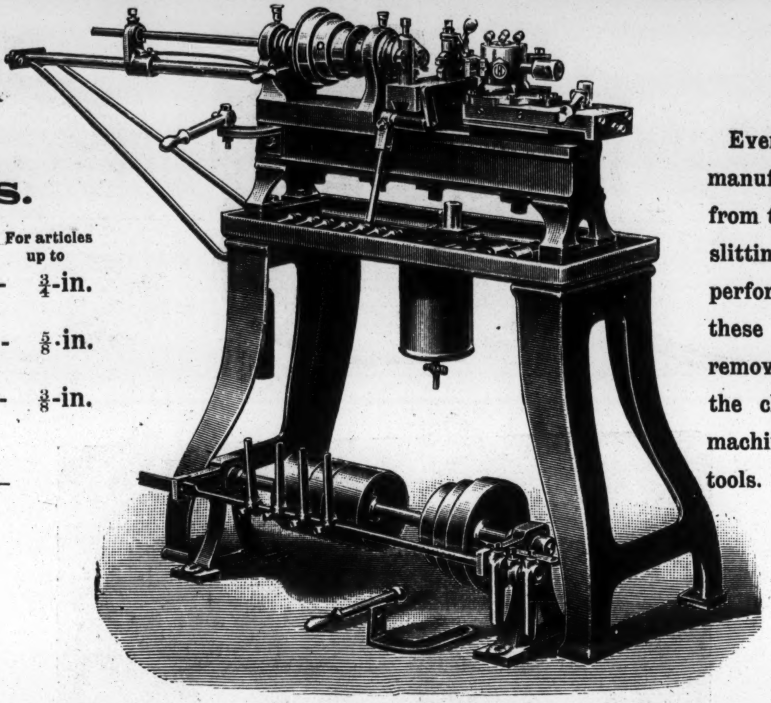

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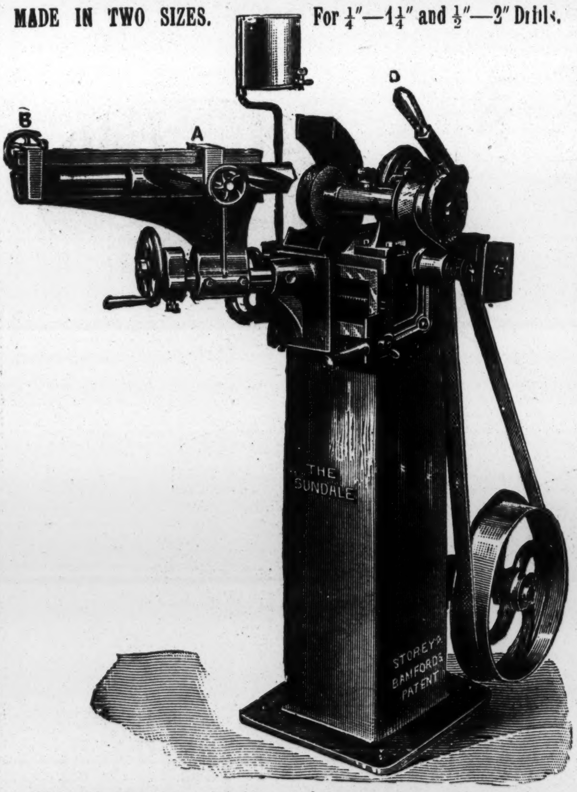

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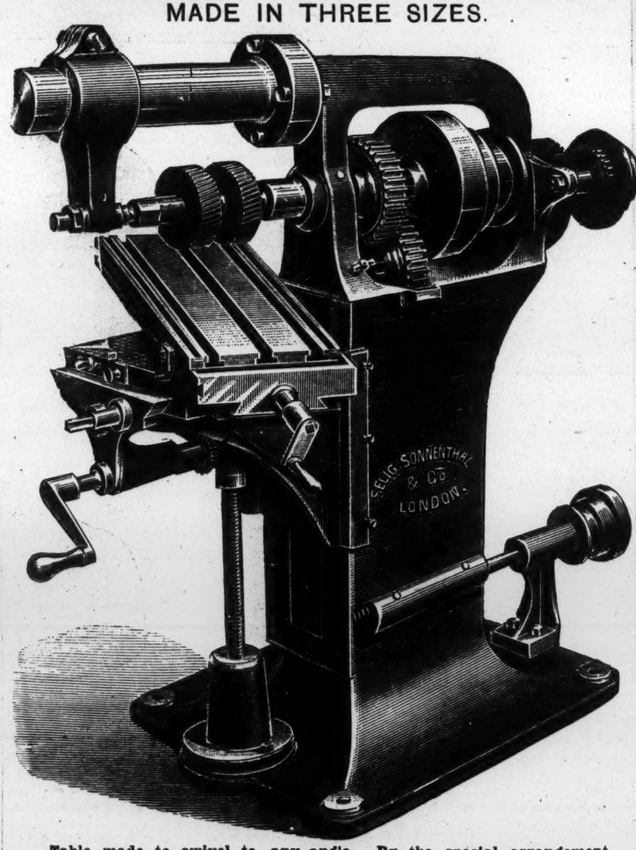

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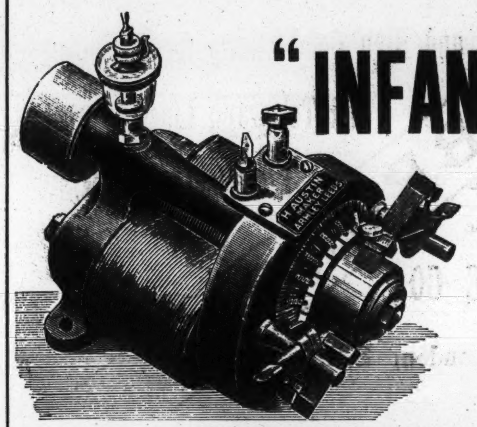

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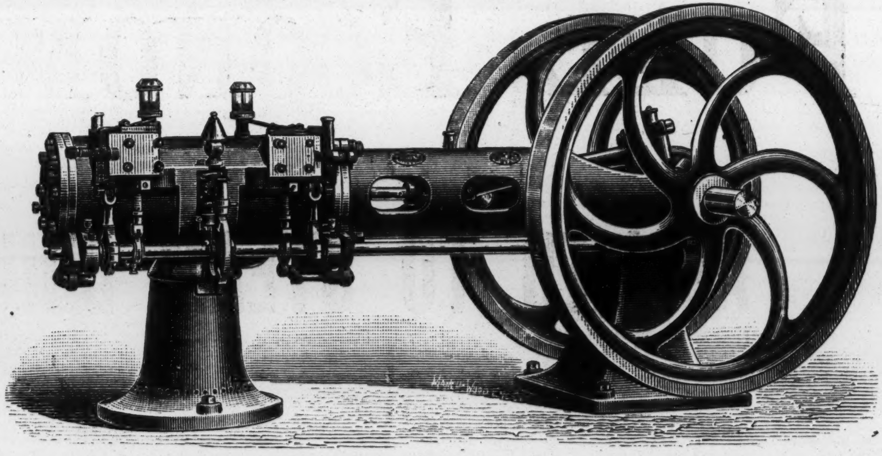

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INDEX TO ADVERTISEMENTS.

The names of Advertisers, whose announcements are ordered for a series, are entered under any one Heading in this Index free of charge but if repeated under other headings, 6d. per week is charged for each additional entry.

PAGE

Accumulators.
- Crompton-Howell Elec. Storage Co.
- Drake & Gorham ... ...
- J. Stiff & Sons (Boxes only) ...

Arc Lamps.—J. H. Holmes & Co. *Sup.* 11
- Johnson & Phillips 1
- F. M. Newton & Co. 17
- Planet Elec. Engineering Co. ... 5
- Poole & White ... ... *Sup.* 17
- J. & W. Roper 14
- Simplex ... ... *Sup.* 8
- Statter & Co. 19

Asbestos.—Bell's Asbestos Co. 20, 21
- United Asbestos Co. 3

Auctioneers and Valuers (Mechanical).
- Wheatley Kirk, Price & Goulty *Sup.* 11

Batteries.
- India-rubber, G.P. & Tel. Wks. Co. 24
- Johnson & Phillips 1
- Telegraph Mfg. Co. ... *Sup.* 4

Battery Jars.—J. Bourne & Son ... 15
- J. Stiff & Sons ... ...

Bells.
- Genl. Elec. Co., Ld. (G. Binswanger.) *Sup.* 10
- Poole & White ... ... *Sup.* 17
- Sheppard, Allarton & Madeley *Sup.* 6

Boilers.—Babcock & Wilcox Co. *Sup.* 2
- Ewen & Co. ... ... *Sup.* 16
- Robey & Co. 18

Books.—Berly's Elec. Directory *Sup.* 15
- Crosby, Lockwood & Son ... ...

Cabinet Work.—W. M. Foxcroft ... 3

Castings.—J & J. Hughes 14
- Phosphor Bronze Co. 10

Chemicals.—G. Boor & Co. ... ...

Dynamos—Andrews & Preece *Sup.* 7
- H. Austin 9
- Bolling & Lowe ... ...
- Charlesworth, Hall & Co. ... ...
- Gülcher Electric Light & P. Co. 15
- J. H. Holmes & Co. ... *Sup.* 11
- Johnson & Phillips 1
- Laurence, Scott & Co. ... ...
- F. M. Newton & Co. 17
- C. Oppermann 6
- C. A. Parsons & Co. ... *Sup.* 6
- J. & W. Roper 14
- Stanley & Davies ... ...
- J. G. Statter & Co. 19

Ebonite.
- Harburg India Rubber Comb Co. *Sup.* 11
- D. Moseley & Sons... ... ...
- North British Rubber Co ... 19

Electrical Engineers and Contractors.
- Acme Electric Works ... *Sup.* 7
- J. D. F. Andrews & Co. 6
- Andrews & Preece ... ... *Sup.* 7
- Appleton, Burbey & Williamson *Sup.* 18
- Blakey, Emmott & Co., Ltd. ... 6
- R. Bolton & Co. 15
- Callender's Bitumen Tel. &c. Co. ... 13
- Charlesworth, Hall & Co. ... ...
- Crompton & Co. ... ... *Sup.* 20
- Drake & Gorham ... ...
- Elliott Bros. ... ... *Sup.* 12
- General Elec. P. & Traction Co. ...
- W. T. Goolden & Co. ... *Sup.* 13
- India-rubber & Telegraph Works Co. 24
- Johnson & Phillips 1
- Laurence, Scott & Co. ... ...
- Paterson & Cooper 23
- Rashleigh Phipps & Dawson ... 12
- C. A. Parsons & Co. ... *Sup.* 6
- Reid Bros. 13
- Ernest Scott & Co. 19
- Ronald A. Scott ... ... *Sup.* 5
- Sharp & Kent ... ... *Sup.* 13

Electrical Engineers, &c.—*Cont.* PAGE
- M. Holroyd Smith ... ... *Sup.* 7
- Swinburne & Co. ... ...
- Telegraph Mfg. Co. ... *Sup.* 4
- Western Electric Company *Sup.* 20
- Westinghouse Electric Co. *Sup.* 20
- Woodhouse & Rawson United 7 & 13

Electric Light.
- Brush Electrical Engineering Co. 12
- Bernstein Electric Lamp Co. ... 14
- India-Rubber, G. P. & Tel. Wks. Co. *Sup.* 1
- Johnson & Phillips 1
- Laurence, Scott & Co. ... ...

Electric Light Carbons.
- Cathcart & Peto 9
- H. & F. Chamberlain 6
- Genl. Elec. Co., Ld. (G. Binswanger.) *Sup.* 10
- Johnson & Phillips 1
- Lacombe & Co. ... ...
- Poole & White ... ... *Sup.* 17
- Woodhouse & Rawson United 7 & 13

Electric Light Fittings.
- Dorman & Smith 11
- Electrical Accessories Co.... 5
- Faraday & Son 12
- Genl. Elec. Co., Ld. (G. Binswanger.) *Sup.* 10
- Rashleigh Phipps & Dawson ... 12
- Poole & White ... ... *Sup.* 17
- B. Verity & Sons 14
- Walsall Electrical Co. 16
- Woodhouse & Rawson ... 7 & 13

Engines for Electric Light.
- W. H. Bailey & Co. 18
- Browett, Lindley & Co. ... *Sup.* 3
- Charlesworth, Hall & Co. ... ...
- Davey, Paxman & Co. 12
- Greenwood and Batley 4
- Griffin Gas Engine 9
- Marshall, Sons & Co. 19
- John Musgrave & Sons ... *Sup.* 2
- Ransomes, Sims & Jefferies ...
- Robey & Co. 18
- Stockport Gas Engine ... *Sup.* 9
- Willans & Robinson ... *Sup.* 19

Enamel.—Aspinall & Co. ... ...

Engraving.—Gilkes ... ...

Fibre.—David Moseley & Sons ...

Fuel Economisers.—E. Green & Son 10

Glass Manufacturers.
- Genl. Elec. Co., Ld. (G. Binswanger.) *Sup.* 10
- Poole & White ... ... *Sup.* 17

Incandescence Lamps.
- Brush Electrical Engineering Co. 12
- Poole & White ... ... *Sup.* 17
- Sunbeam Lamp Co. ... *Sup.* 3
- Woodhouse & Rawson United 7 & 13

India-Rubber.
- India Rubber, G. P. & Tel. Wks. Co. 24
- D. Moseley & Sons ... ...

Insulators, &c.—Bourne & Son ... 15
- Poole & White ... ... *Sup.* 17
- Stiff & Sons ... .
- Telegraph Mfg. Co. ... *Sup.* 4

Lubricants.—W. H. Willcox & Co. ... 3

Magnet Steel.—G. P. Wall 17

Manufacturing Electricians.
- Cox-Walkers 15
- Croggon & Co. 2
- Dorman & Smith 11
- Elliott Bros. 2
- A. B. Gill & Co. 6
- Hartmann & Braun ... ...
- International Electric Co. ...
- King, Mendham & Co. 17
- Laurence, Scott & Co. ... ...
- Nalder Bros. ... ... *Sup.* 9
- J. Orme & Co. ... ...
- Poole & White ... ... *Sup.* 17

PAGE

Manufacturing Electricians.—*Cont.*
- Price, Talbot & Co. ... *Sup.* 2
- Telegraph Mfg Co. ... *Sup.* 4
- H. Thorpe 6
- Walsall Electrical Company ... 16
- Jas. White ... ...
- Woodhouse & Rawson United 7 & 13
- F. Zöpke ... ... *Sup.* 16

Mica.
- R. McGoune, Buchanan & Co. *Sup.* 12
- F. Wiggins & Sons 3

Motors.—Charlesworth, Hall & Co. ...
- Cuttriss & Co. 14
- Gülcher Electric Light & P. Co. 15

Patent Agents.—H. Gardner ... 3
- J. G. Lorrain ... ... *Sup.* 12

Pole Finding Paper.—O. Berend & Co.

Poles.
- Johnson & Phillips (Wood and Iron). 1
- Joseph Aird (Wrought Iron and Steel). 2

Porcelain Appliances.
- Dorman & Smith 11
- Genl. Elec. Co., Ld. (G. Binswanger.) *Sup.* 10
- Poole & White ... ... *Sup.* 17
- Taylor, Tunnicliff & Co. 15

Porous Cells.—J. Stiff & Sons ...

Projectors.
- Charlesworth, Hall & Co. ... ...

Railway Signals.—Saxby & Farmer 12

Schools and Classes.
- School of Telegraphy 23

Screws.—Davis & Timmins 22
- A. Stokes & Co. ... ...

Switches.
- Appleton, Burbey & Williamson *Sup.* 18
- Faraday & Son 12
- Genl. Elec. Co., Ld (G. Binswanger.) *Sup.* 10
- The Paiste Switch... ... *Sup.* 3
- Poole & White ... ... *Sup.* 17
- Walsall Electrical Co. 16
- Woodhouse & Rawson United 7 & 13

Telegraph Engineers.
- Buller, Jobson & Co. ... *Sup.* 1
- Johnson & Phillips 1
- Telegraph Mfg. Co. ... *Sup.* 4

Telephones.—Baughan & Co. ...
- Consol. Tel. Const. & M. Co. *Sup.* 6
- Stanhope Co. 6
- Universal Telephone Co. ... ...

Tools, Lathes, &c.
- Chas. Churchill & Co. ... *Sup.* 7
- Selig, Sonnenthal & Co. ... *Sup.* 6

Tubes.—Joseph Aird 2

Turbines.—F. Nell ... ... *Sup.* 7

Wire (covered).
- Fowler-Waring Cables Co. *Sup.* 19
- W. T. Glover & Co. 2
- W. T. Henley's Telg. Works Co. ... 4
- London Electric Wire Co. *Sup.* 1
- Midland Electric Wire Co. ... 15
- Phillips Bros. 23
- Poole & White ... ... *Sup.* 17
- Telegraph Mfg. Co. ... *Sup.* 4
- United Electric Wire Co.... ... 6
- Woodhouse & Rawson United 7 & 13

Wire (uncovered).—Davis & Timmins 22
- Ramsden, Camm & Co. 15
- F. Smith & Co. 3

Wire Covering Machinery.
- T. Barraclough & Co. 6

Wood Casings.—
- Genl. Elec. Co., Ld. (G. Binswanger.) *Sup.* 10
- J. F. & G. Harris 17
- Poole & White ... ... *Sup.* 17
- Vigers Bros. 14
- Woodhouse & Rawson United 7 & 13

BOOK ADVERTISEMENTS APPEAR ON Page 14 OF SUPPLEMENT.

MISCELLANEOUS ADVERTISEMENTS *relating to Situations, Articles for Sale and Wanted, &c., &c., appear on Sup.* 11 *(middle of paper.)*

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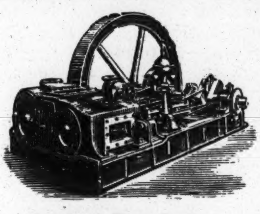

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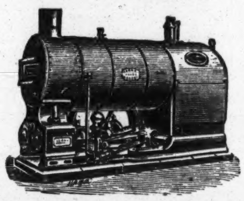

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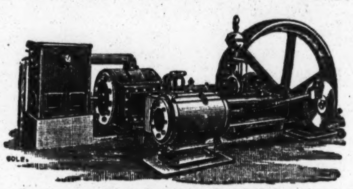

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VOL. XXVII. NOVEMBER 7, 1890. No. 676

CONTENTS:

PAGE
The Electro-Deposition of Copper 541
The City and South London Railway 542
Fraudulent and Doctored Telegrams 544
A Synthetic Study of Dynamo Machines (*continued*) ... 545
M. E. Mares's Electrical Energy Meter (*illustrated*) 546
The Copenhagen Central Station 548
A New Electrical Apparatus for Determining Melting Points (*illustrated*) 548
Tele-Photography (*illustrated*) 549
Industrialism 551
A New Asbestos-Faced Valve (*illustrated*) 554
The City and South London Railway (*illustrated*) 554
London County Council 558
Legal:—Halifax and Bermuda Cable Company *v.* Magniac... 558
Edison Electric Light Company *v.* Robertson 559
Notes 559
PAGE
City Notes, &c. :—Westminster Electric Supply Corporation 563
Montevideo Telephone Company 564
West India and Panama Telegraph Company 564
Traffic Receipts 564
Share List of Electrical Companies 565
The Electro-magnet (*illustrated*) (*continued*) 566
New Patents 568
Abstracts of Published Specifications 568
Correspondence :—Telephone Switchboards 569
A Speedy Method of Localising Defects in an Electric Lighting Cable (*illustrated*) 569
Rule for Electric Bell and Alarm Wiring... 569
The Elmore Copper Process... 570
The Lane-Fox Patents 570
The Electro-Deposition of Copper 572
Accumulator Explosions 572

THE ELECTRO-DEPOSITION OF COPPER.

IN our correspondence columns we publish a letter from Mr. W. Stepney Rawson which necessitates a few remarks on our part. We have to thank Mr. Rawson for his letter. If he only appreciated our anxiety to place before our readers any information we can obtain which would help them to arrive at a correct judgment on the question he would have made his letter longer, and we should have been glad to find room for any facts and figures it might have contained. Our correspondent writes apparently in some haste and with some warmth, but we must make allowances for one who, having only just returned from abroad, seems scarcely at home with his subject.

Mr. Rawson has selected eight points from our recent articles on the electro-deposition of copper, in order to demonstrate how utterly in the wrong we have placed ourselves, and he doubtless thinks that any reply we can make will be of little avail; that, however, we are content to leave to the unbiassed judgment of our readers. It will be noticed that our calculations and deductions are held to be practically ridiculous, whatever that may mean, although the writer takes care not to give any figures to show that they are theoretically incorrect; but we will let that pass, and assume, for the sake of argument, that Mr. Rawson's knowledge of the electro-deposition of copper is far greater than that of any of the eminent scientists and authorities we have credited with the responsibility of certain data. Let us also take it that the figure quoted on the authority of Mr. Sprague, viz., "that the maximum allowable current for obtaining proper deposition is 18 ampères per square foot of surface of the electrodes," is more than double of what is possible in ordinary commercial depositing, and reduce it, say, to 7 ampères; and, according to Mr. Rawson's assertion, we will admit that in the Elmore process the current density is three times this amount. The difference between this result and the figure taken by us for our calculation is so small that we fail to see the force of his contention, especially as we clearly stated that probably by the use of the burnisher a somewhat heavier current might be employed per square foot of surface.

Mr. Rawson is equally at fault on the horse-power question, for he has not taken into consideration our article of the 24th ult., in which we compared a German establishment working 144 hours per week with the Elmore factory on Dr. Hopkinson's estimate of 161 hours.

It is not for us to reconcile the figures of cost on p. 479 with anything whatever; they are not of our compiling, but are given by Fontaine as the actual expenses in three works. It is for our correspondent to show that the Elmore process does not involve an expenditure of more than one-third of the amounts there given as the experience of years. The power, it will be observed, in this table varies from 20 to 50 per cent. of the total cost; which of these percentages does Mr. Rawson deem most applicable to the Elmore case? Let him read more carefully what Fontaine says regarding the cost of fuel; the French authority quotes only 5s. per ton, and yet asserts that motive power costs in Birmingham 125 francs per ton of copper. Mr. Rawson, therefore, instead of being surprised that we dared to estimate the expenses of electrical deposition on an assumption opposed to experience, should have set himself to work to show how the figures we gave as the results of actual practice can so differ from those which he presumably possesses but fails to produce when wanted.

We have shown, by an exhaustive comparison with the Mouchel copper, why there is no reason to anticipate any extraordinary demand for high conductivity Elmore copper wire; Mr. Rawson simply asserts his belief that the company can show a handsome profit in this department; indeed, his communication is entirely made up of assertions and opinions, but not one fact does he bring forward in support of them.

We beg to assure Mr. Rawson that if he will again carefully peruse our comments, he will fail utterly to

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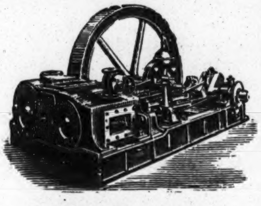

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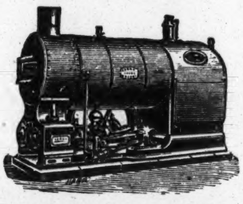

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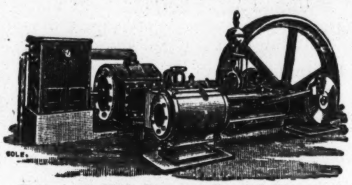

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CONTENTS:

PAGE
The Electro-Deposition of Copper 541
The City and South London Railway 542
Fraudulent and Doctored Telegrams 544
A Synthetic Study of Dynamo Machines (*continued*) 545
M. E. Mares's Electrical Energy Meter (*illustrated*)... ... 546
The Copenhagen Central Station 548
A New Electrical Apparatus for Determining Melting Points (*illustrated*) 548
Tele-Photography (*illustrated*) 549
Industrialism 551
A New Asbestos-Faced Valve (*illustrated*) 554
The City and South London Railway (*illustrated*) 554
London County Council 558
Legal:—Halifax and Bermuda Cable Company *v.* Magniac... 558
Edison Electric Light Company *v.* Robertson 559
Notes 559
PAGE
City Notes, &c. :—Westminster Electric Supply Corporation 563
Montevideo Telephone Company 564
West India and Panama Telegraph Company 564
Traffic Receipts 564
Share List of Electrical Companies 565
The Electro-magnet (*illustrated*) (*continued*) 566
New Patents 568
Abstracts of Published Specifications 568
Correspondence :—Telephone Switchboards 569
A Speedy Method of Localising Defects in an Electric Lighting Cable (*illustrated*) 569
Rule for Electric Bell and Alarm Wiring... 569
The Elmore Copper Process... 570
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The Electro-Deposition of Copper 572
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THE ELECTRO-DEPOSITION OF COPPER.

IN our correspondence columns we publish a letter from Mr. W. Stepney Rawson which necessitates a few remarks on our part. We have to thank Mr. Rawson for his letter. If he only appreciated our anxiety to place before our readers any information we can obtain which would help them to arrive at a correct judgment on the question he would have made his letter longer, and we should have been glad to find room for any facts and figures it might have contained. Our correspondent writes apparently in some haste and with some warmth, but we must make allowances for one who, having only just returned from abroad, seems scarcely at home with his subject.

Mr. Rawson has selected eight points from our recent articles on the electro-deposition of copper, in order to demonstrate how utterly in the wrong we have placed ourselves, and he doubtless thinks that any reply we can make will be of little avail; that, however, we are content to leave to the unbiassed judgment of our readers. It will be noticed that our calculations and deductions are held to be practically ridiculous, whatever that may mean, although the writer takes care not to give any figures to show that they are theoretically incorrect; but we will let that pass, and assume, for the sake of argument, that Mr. Rawson's knowledge of the electro-deposition of copper is far greater than that of any of the eminent scientists and authorities we have credited with the responsibility of certain data. Let us also take it that the figure quoted on the authority of Mr. Sprague, viz., "that the maximum allowable current for obtaining proper deposition is 18 ampères per square foot of surface of the electrodes," is more than double of what is possible in ordinary commercial depositing, and reduce it, say, to 7 ampères; and, according to Mr. Rawson's assertion, we will admit that in the Elmore process the current density is three times this amount. The difference between this result and the figure taken by us for our calculation is so small that we fail to see the force of his contention, especially as we clearly stated that probably by the use of the burnisher a somewhat heavier current might be employed per square foot of surface.

Mr. Rawson is equally at fault on the horse-power question, for he has not taken into consideration our article of the 24th ult., in which we compared a German establishment working 144 hours per week with the Elmore factory on Dr. Hopkinson's estimate of 161 hours.

It is not for us to reconcile the figures of cost on p. 479 with anything whatever; they are not of our compiling, but are given by Fontaine as the actual expenses in three works. It is for our correspondent to show that the Elmore process does not involve an expenditure of more than one-third of the amounts there given as the experience of years. The power, it will be observed, in this table varies from 20 to 50 per cent. of the total cost; which of these percentages does Mr. Rawson deem most applicable to the Elmore case? Let him read more carefully what Fontaine says regarding the cost of fuel; the French authority quotes only 5s. per ton, and yet asserts that motive power costs in Birmingham 125 francs per ton of copper. Mr. Rawson, therefore, instead of being surprised that we dared to estimate the expenses of electrical deposition on an assumption opposed to experience, should have set himself to work to show how the figures we gave as the results of actual practice can so differ from those which he presumably possesses but fails to produce when wanted.

We have shown, by an exhaustive comparison with the Mouchel copper, why there is no reason to anticipate any extraordinary demand for high conductivity Elmore copper wire; Mr. Rawson simply asserts his belief that the company can show a handsome profit in this department; indeed, his communication is entirely made up of assertions and opinions, but not one fact does he bring forward in support of them.

We beg to assure Mr. Rawson that if he will again carefully peruse our comments, he will fail utterly to find any reference reflecting on the quality of the articles. With regard to the last paragraph of Mr. Rawson's letter we may say that we have no intention of discussing with him the question of high principles, and we venture to think his letter would have been improved by the omission of the sarcasm. As he has undoubtedly misunderstood the purport of some of our remarks perhaps we ought to make them clear to him. We examined the patents and the reports on them as we examined other points. We found the general exaggeration to be common to them too. The value of the patents was the question. Messrs. Woodhouse and Rawson should be aware that if an invention is successful there are always people ready to "steal the ideas of the inventor," as our correspondent puts it. The object of a patent is to prevent their doing so, and the value of a patent depends upon the extent to which it does prevent their doing so. Any flaw which may exist is taken advantage of in defending a patent suit; and the possibility of the existence of such flaws is a most material factor in considering the value of a patent. The only surprise to us is, that with Messrs. Woodhouse and Rawson's practical experience in this particular line, they should have failed to give due importance to this consideration. Mr. Rawson's trained mind has enabled him to observe in our remarks on this point a sinister suggestion which they were not intended to contain; nevertheless, we imagine that the same high principles which influenced his firm to promote company after company on the strength of the Elmore patents, will not be entirely absent from the minds of future inventors who would also like to participate in the benefits to be derived from electro-deposition.

We need not remind our correspondent that it is through no fault of ours that we have failed to see the process; will he now, as we are unable to do so, publicly give, in a table similar to that to which he refers on page 479, the various details which go to make up a total cost of but £5 per ton for Elmore copper?

A contemporary last week published an article from the pen of Dr. Gore, in which we consider there is much to support our previous contentions, and the writer concludes thus:—"In consequence of the numerous circumstances which affect the cost, an approximately satisfactory estimate of the total amount of capital required to be invested in establishing an electrolytic refinery to deposit a given amount of copper daily, can only be arrived at by means of a knowledge of all the essential particulars in the given case."

As Mr. Rawson is perfectly conversant with "all the essential particulars" we require, let him place, then, before us the items mentioned in Dr. Gore's *Recapitulation.*

THE CITY AND SOUTH LONDON RAILWAY.

THE inauguration of this enterprise on Tuesday afternoon was a great success in almost every respect, and we must congratulate the City and South London Railway Company and its officials not only on a splendid engineering achievement, but also on the excellent social arrangements during the opening ceremony. Punctually at noon, their Royal Highnesses the Prince of Wales and the Duke of Clarence and Avondale arrived at the City terminus, where they were received by the chairman of the company, Mr. C. G. Mott. After descending the hydraulic lift in its handsomely furnished cage, the Prince of Wales proceeded to turn a small switch with a gold key, giving thereby the signal for the current to be turned into the conducting mains. This act was witnessed by the Lord Chancellor, the Lord Mayor and the Sheriffs; Mr. J. H. Greathead (engineer); Mr. T. C. Jenkin (manager); Mr. H. H. M. Smith (secretary); Mr. C. E. Spagnoletti (consulting electrician); General Hutchinson and Major Cardew (Board of Trade); and Sir John Fowler (consulting engineer).

Ten minutes later, after examining the electric locomotives and carriages, the Prince and some forty gentlemen boarded the train, which consisted of two saloon cars. The engine was in charge of Mr. W. Mather, M.P., and Dr. Edward Hopkinson, and it was driven by Mr. G. A. Grindle, accompanied by Dr. John Hopkinson. Nine minutes later the Oval Station, 2½ miles distant, was reached, the intermediate stations —Borough, Elephant and Castle, and Kennington— being passed without a halt. After examining the Oval Station and its equipments, the party re-entered the train and proceeded to the South-West terminus at Stockwell. An excellent luncheon was then served in a tastefully-decorated Indian pavilion, where about 300 invited guests sat down. Mr. C. G. Mott presided, having on his right the Prince of Wales and on his left the Duke of Clarence and Avondale. Besides the gentlemen previously mentioned there were present:— Sir F. Abel, Sir F. Bramwell, Sir B. Baker, Sir H. Roscoe, Sir Douglas Galton, Sir E. Reed, M.P.; Mr. Causton, M.P.; Sir John Monckton, Sir H. Tyler, Mr. Henry Tate, and other notabilities. The electrical fraternity, not directly connected with this enterprise, was represented by Sir David Salomons, Dr. Silvanus P. Thompson, Mr. W. Raworth, Mr. A. P. Trotter, Mr. A. Reckenzaun, and Mr. F. Wynne.

After luncheon, the Prince of Wales, when replying to the usual second loyal toast, proposed "Success to the City and South London Railway" in most appropriate and happy terms. The Chairman acknowledged the compliments of His Royal Highness and stated that the design of the railway was that of Mr. Greathead, who had carried it out under his own superintendence, aided by the company's consulting engineers Sir John Fowler and Sir Benjamin Baker.

Running, as it did, under the streets, without interfering with property on the surface, the undertaking promised to be remunerative. With regard to the motive power, it was originally intended to be worked by an endless cable, but the directors had decided that this plan was not the best for their purpose, and consequently adopted electricity, on the method suggested by Messrs. Mather and Platt, worked out by Dr. Edward Hopkinson, in conjunction with his brother Dr. John Hopkinson.

As we are giving a complete description of its technical details in another column, we shall only dwell upon the general impressions formed both at a private view and during the opening celebration. We were particularly struck with the novelty and originality of construction which was apparent on every side, and this is the best testimony to the genius of the originators of this extraordinary enterprise. Every praise is due, not merely to the engineers and architects for designing a great work which combines utility and comfort, but also to the pluck of the directors and shareholders who had unlimited faith in the abilities of the technical staff.

Although the method of working a train electrically is not new, the scale upon which electric propulsion is carried out is, in this case, quite unprecedented; it is the largest undertaking of its kind in the world, and we believe it will be the forerunner of even greater things in this domain. The City and South London Railway Company has the advantage of knowing beforehand what its traction expenses will be, for the enterprising contractors, Messrs. Mather and Platt, guarantee that for the first two years it shall not exceed 3½d. per train mile. On the Metropolitan Underground Railway, where steam locomotives (the product of 50 years' inventions and improvements) are used, the haulage cost is 10d. per mile, with a train capacity of 450 passengers. But these require much larger tunnels, and have to maintain a permanent way twice as heavy to accommodate their steam and smoke emitting locomotives.

Messrs. Mather and Platt have carefully calculated the probable expenditure of energy, and based their estimate upon well-known facts. Out of every 100 units of power developed by the boilers, 75 will be given out in electricity by the dynamos at the generating station; the average loss in the conductor will be at most another 5 per cent., rising from nothing at the central station to 10 per cent. at the extreme end of the line. Leakage, with the system of insulation adopted, will be almost *nil*. It is claimed that the motors give an efficiency of 90 per cent., and, since there is no gearing, the armatures being placed directly upon the driving axles, there should be a total estimated efficiency of 64 per cent.; if, in practice, the efficiency should not reach this high percentage there need be no alarm, considering the fact that the stationary boilers can be fed by burning coal of a quality which is not much more than half the price of best Welsh coal necessary in steam locomotives.

Accidents do happen, even on the oldest and best regulated railways. That the City and South London Railway is not exempt from this law was demonstrated on Tuesday afternoon. After luncheon at 3.30, a large party proceeded to the Stockwell Station platform, to be conveyed to the City as a *finale* to the day's programme. They waited until after 4 o'clock, but no train came in sight, and then the chairman announced that through some accident no more trains would be run that afternoon, and the guests thereupon dispersed to return by any of the existing conveyances on the surface roads. Too much importance must not, however, be attached to this incident, for the initial proceedings are necessarily incomplete, and smooth working will follow with experience.

It is claimed that this railway has a great advantage over others in the way of safety to passengers. In the event of a train breaking down, the current will be cut off from the section, and it cannot be run into by a train following. The passengers can get out and walk to the next station, which in no case exceeds a distance of one-third of a mile.

The safety appliances on the line, as on the trains, leave nothing to be desired, and altogether the whole scheme deserves the admiration and encouragement of all.

Storage Batteries.

IN letters written by Mr. H. W. Miller, Engineer to the Kensington and Knightsbridge Electric Lighting Company, and Prof. A. B. W. Kennedy, Engineer to the Westminster Electric Supply Company, with reference to the Crompton-Howell storage accumulators, testimony is given as to the efficiency of the same, as the result of four years' working. Although there appears to be satisfactory evidence that the cells are doing excellent work, a few more definite figures would have been advisable. Mr. Miller, for instance, states that in his opinion "an average renewal of six to seven per cent. of the positive plates is enough." Why could not the actual renewals have been stated; were they actually greater than six to seven per cent., and if so, why? The efficiency obtained in practice is stated to be 85 per cent., a good result. Prof. Kennedy makes no remarks on depreciation, except that after 11 months' use nothing in the way of repairs had been done, a rather valueless statement. The battery appears to stand a heavy current being drawn from it without injury, a current of 250 ampères for half an hour having been taken on an emergency, the nominal capacity of the whole being 500 ampère hours. In view of the trouble so often experienced in the management of accumulators, it is satisfactory to find really good results obtained.

The French Elmore Company.

THE directors of the French Elmore Company have issued a circular to their shareholders announcing the appointment of Mons. Secretan as manager, and the issue of £50,000 debentures to the parent company, to provide the additional working capital which becomes necessary by reason of Mons. Secretan's belief in the process and the greater developments which may, in consequence, be expected. We can only characterise the circular as an elaborate puff with no solid substance in it. We have already given our advice to the shareholders. As this circular has been widely published, it may not be out of place to caution those who are not shareholders against being misled into becoming so on the faith of any statements whatever short of accomplished facts.

FRAUDULENT AND DOCTORED TELEGRAMS.

THE trial and conviction at the Central Criminal Court last Saturday week of an individual vaguely described as a commission agent, but who, more correctly speaking, should be called a telegraph clerk, and who was recently in the service of the Government, provides a fitting sequel to a series of fraudulent operations, which had for their object the plundering, by a system of deliberate swindling, of those apparently indispensable "professional" gentlemen who both on the racecourse and in town carry on the sporting business of "bookmaking."

For the professional racing man, whether "booker" or "backer," we have no particular feeling of sympathy or admiration, and though his praises have been sung very frequently in public, we suspect that the burthen of such adulatory lays have almost invariably been inspired, if not directly at least indirectly, by something approaching a "vested interest" in the ramifications of his quasi-equine profession. The threadbare argument of the almost romantic love of Englishmen for horses, is one which has often been used to account for the mushroom-like growth of our racecourses; the amazing increase in the number and value of the races run, and the extraordinary prices given for thoroughbred stock, to say nothing of the fancy sums necessary for the propitiation of the "favourite jockeys" of the present day. However charming and soothing such sophistry may be, it does not offer a substantial explanation of our national extravagance on this peculiarly British subject, and the few apologists who argued the consequent improvement of the English thoroughbred as likely to be worth the price paid for it, have now retired into the region of utter darkness. There is one thing pretty certain, and that is this, that the "professional sportsman" has not got many high-fangled notions as to the sentimental or romantic; least of all in horse lore; it is plainly "win, tie, or wrangle," with him. The money is the sport and the spoil; the love of the horse once so desperately pleaded is merely a means to an end. Remind the average racing man of the classics of the horse; attempt to draw his impressionable soul into the history; more or less mythological, of Abaster, Aethon, Arion, Bayard, Borak, Rosinante, Xanthos, Sleipnir, or even such comparatively modern and material equine worthies as Bucephalus, Copenhagen and Black Bess. With the exception of perhaps the latter, he will know nothing of them; and to throw a light on his darkness he will probably ask what race they ran in, what weights they carried, and who trained them.

It was not the love of the horse which led the young man, Henry Ives, to the plotting and planning of an ingenious, yet artful and unprincipled scheme for the systematic swindling of the betting man, Pratt. Ives's plan, which we shall describe, was one which necessitated the aid of a confederate or confederates in the Central Telegraph Office; and, though it had been planned and resorted to before by a clerk not now in the telegraph service, and who cannot be found by the police, yet, sad to say, there were those who were willing to run the risk of detection and disgrace for the prospect of gaining a few pounds criminally and dishonestly. We will suppose a race as being set for decision at two o'clock. Henry Ives handed in a telegram addressed to "Jackson, High Street, Sunderland," at about a quarter to two. The address on the telegram was a bogus one, as was also the text, but it enabled the message form, which was timed 15 minutes or so before the advertised time of the race to reach the hands of the confederate, who was probably engaged at or near what is known as the Sunderland circuit. Here it was detained until the result of the race was known, then the address and the text, which had been lightly written, were erased, and a new and correct address having been substituted, the text was altered to a request to back so and so (the actual winner) for so many pounds; the message was then put rapidly into circulation, and delivered to the addressee, a betting man. Ives had the authority of another betting man, named Miller, to use his name; Pratt, the recipient of the telegram, would, unless suspicions were aroused, imagine the telegram, from the early time it bore, to be a genuine one from his "client," Miller, and would book the amount to his credit accordingly.

It is quite possible that this clever, though unprincipled scheme, has been managed successfully before; but how often, of course, will never be known. It is probable that the large sums which were being put on in the name of Miller, and the unvarying success attending their outlay, aroused the suspicions of Pratt.

The jury had no difficulty in finding a verdict, and the plea usually put forward on such occasions in extenuation of guilt was once more forthcoming.

Henry Ives, like many others in his unfortunate and disgraceful position, advanced the time-worn excuse of being the dupe of others, who were older.

It may be the business of legal gentlemen, when all other excuses fail, to put forward the plea of "the dupe" in defence of their clients, but such generalities ought not to stand in the way of the punishment of the swindler and the thief.

The fact that sentence was deferred indicates that there may be some effort made to get Ives to say who has duped him; but anxious though most people are to see justice tempered with mercy to those who yield to sudden and overwhelming temptation, the circumstances of the case under notice suggest that there was neither sudden temptation nor temporary failure of moral rectitude, but rather that the whole matter was the outcome of a cunningly contrived, and ingeniously carried out, system for subverting the working of the telegraphic system to the nefarious ends of unprincipled and lawless men.

The Postal Telegraph Service derives a large revenue from the professional racing man, and, indeed, in this respect, our Government presents a strange anomaly, for with one service it caters and canvasses for the custom of racing men by extending telegraph communication to every conceivable place where racing of any importance is carried on; and with another institution, namely, the police, it gloriously upholds the State enactment that betting is illegal, and in the newspapers we may read that 10,000 messages were despatched on Derby Day from Epsom, or from Doncaster on the St. Leger Day (and what were they if they were not betting messages?), and in the next column find that the police have made a most successful raid on betting men, and that the magistrates have imposed heavy fines. Doubtless, with the elimination of the bookmaker, the interest in racing would become languid and tame, and if any excuse can be made for retaining him, it may be found that in the present condition and routine of society he is, as Robertson, in his comedy of "Ours," has said of matrimony—"a necessary evil, which at present we are unable to do without."

Betting, as carried on at the present time, seems to be an ever-growing practice of at least doubtful respectability, and, possibly, is able to boast as a business that it is not over-stocked, even in these days of limited trade and unlimited labour. The racing man's so-called love of the horse is the offspring of mercenary practices, and may be gauged by the volcanic explosion of appalling language which follows the defeat of the "beloved" steed, to whose chance of "getting home" he had entrusted some portion of his ill-gotten wealth. His anguish at such times may possibly partake of the classic, though this cannot be said of his love of the racehorse, or, indeed, of his language.

At all events, it must be admitted that he is entitled to the same measure of fair play, consideration, and protection at the hands of the telegraph service as any other person making use of its lines and *employés*, and it may be that Henry Ives, in durance vile, will have plenty of time to think of the squandered years and lost opportunities of his young life, and make resolves for a better future, or he may prefer to plot and plan some other ingenious combination of intelligence and cunning which will hereafter still further advance him on the road to ruin.

A SYNTHETIC STUDY OF DYNAMO MACHINES.

(*Continued from page* 356.)

IX.—The Heating of Machines (*continued*).

The temperature which an armature will attain in running depends upon the heat generated due to the three causes already mentioned, on the extent and character of the surface from which the heat is radiated, and on the velocity at which the surface is moving. Generally speaking, the exterior surface of the armature is smooth, but the periphery velocity varies from 3,000 feet per minute in direct current machines to 6,000, or even 8,000 feet per minute in alternators.

As may be imagined, it is difficult, if not impossible, to foretell precisely the extent to which the motion will be effective in dissipating heat, though for ordinary calculations it is assumed that a surface velocity of 3,000 feet per minute is equivalent to adding about one-half to the radiating surface. This, in other words, means that if the temperature of an armature at rest were raised 30° with the normal current, the temperature rise for a velocity of 3,000 feet per minute would be, neglecting hysteresis, only 20°.

For stationary coils wound with double cotton-covered wire, and varnished on the exterior, the equation connecting the rise of temperature with the radiating surface, and the power dissipated is approximately

$$C^\circ = \frac{W\,330}{S}$$

where C° is the rise in degrees Centigrade, W the rate at which energy is dissipated in watts, and S the area of the radiating surface in square centimetres. If the coils are wound on an armature and have a surface velocity of 3,000 feet per minute, the effect being equivalent to increasing the radiating surface, we have as approximately expressing the relation

$$C^\circ = \frac{W\,220}{S}.$$

There is a considerable amount of uncertainty as regards the latter formula, since the part which the surface speed plays in dissipating the heat depends entirely on the construction of the machine. In most armatures wound on the Gramme principle, for instance, the wire in the interior of the core presents a broken surface, which is manifestly more effective in getting rid of the heat than a smooth surface. Again, the spider arms are very often twisted to send a draft through the interior, or spaces are left at intervals in the core, through which the air is propelled by centrifugal force. In drum armatures, a space is sometimes left between the spindle bush and the central opening in the discs. But this space would have little value as far as dissipating heat is concerned, were it not that by twisted vanes or other means a draft is forced through the opening, and without experiment it is difficult to determine the effect a current of air created in this way will produce. The surface velocity makes a great difference to the capacity for dissipating heat, even if the surface is smooth, and there is no forced draft. Mr. Rechniewski considers that the heat which can be dissipated by an armature for a given rise of temperature above the atmosphere is nearly proportional to the peripheral velocity, in which case, taking the effect due to 3,000 feet per minute as indicated by the difference in the coefficients of the two equations, we have the rise in temperature represented by

$$C^\circ = \frac{W\,330}{S\,V\,\cdot0005}$$

where V is the surface velocity in feet per minute. In accordance with this assumption, the value of the surface for heat dissipation is 1·5 times greater when running at 3,000 feet per minute than when at rest, while at a velocity of 6,000 feet it has three times the value. The writer has, however, been unable to test the truth of this supposition, and it is probably best to assume, in the absence of experiment, that the equation holds good only to 3,000 feet per minute, at which velocity plenty of experiments have been made. After this speed is reached, it is possible the proportionality may fall off somewhat; but if the surface is calculated as for 3,000 feet, the machine, at a higher speed, will have the advantage of running cooler.

Of course, the rise in temperature above given relates only to the exposed surfaces of the coils. In the case of stationary close-fitting magnet coils, the temperature next the sheet iron core on which they are wound is higher than at the external surface, but experiments to determine the difference of temperature between the inside and the outside have not been made so far. This difference of temperature may be expressed as the thermal pressure required to send the current of heat through successive layers of cotton-covered copper wire and insulating materials composing the coil, the flow taking place partly from layer to layer through bad conductors, and partly round and round the coiled wire. Though in estimating the cooling surface it is usual to neglect the flanged ends of the cores and the surface next the magnet, counting only the area of the exposed wire, there is undoubtedly some flow of heat towards the interior of the magnets and towards the end flanges, so that a little uncertainty exists regarding the exact area which ought to be regarded as cooling surface. Accordingly the formula, when applied to large coils, may give a greater rise of temperature than will be indicated on test, while applied to small coils the rise it gives may be somewhat less. It is very usual, when coils stand vertically, to make the cores somewhat larger than the magnets, thus leaving a space all round through which flows upwards by convection a continuous current of air. This reduces the difference of temperature between the top and bottom layers of wire, and if it were possible to wind the coils on a skeleton frame, so that half the heat could be carried off in this way, the difference between the temperature of the hottest wire then in the middle of the coil thickness, and the coolest then on both surfaces, would be reduced to about a half of its previous amount. There are, however, many practical objections to this, and in the absence of further experiment, we must content ourselves with keeping the surface temperature down to the limit of 75° C. already given, knowing that if the coils do not exceed $2\frac{1}{2}$ to 3 inches in thickness, there is incurred, with the ordinary windings in use, no danger of overheating due to the greater temperature of the bottom layers. Accordingly, for a machine designed to work in an atmosphere of 40° C., the rise of temperature being fixed at 30°, a radiating surface of 11 square centimetres per watt, as indicated by the formula, would be allowed.

As regards armatures, the same reasoning applies. We argue that if the temperature of the surface does not exceed the limit given, no danger is to be apprehended from the greater temperature inside. In calculating the amount of radiating surface to be allowed, the heating due to hysteresis must, of course, be taken into account, as well as that due to the copper resistance of the conductors. For an armature having a peripheral speed of 3,000 feet per minute, and running in an atmosphere of 40° C., the rise of temperature being then 30°, the formula shows that about 7·4 square centimetres per watt are required for radiation, and this is the usual allowance, in practice, for a rise of 30°. If the rise is to be less, a correspondingly greater surface must be allowed. In cylinder machines, both the interior and exterior surfaces are counted as of equal value, the draft of air through the interior making up for the greater heat generated inside relatively to the amount of surface. In drum machines, the exterior surface is taken along with such proportion of the ends as may be considered of value for radiation.

Sometimes the rising of the surface temperature of an armature after the machine has stopped has been attributed to "accumulation of heat," an expression not very apt in its application to the circumstances. In a long run, the armature must get to a temperature such that the loss of heat is exactly equal to the amount generated, though the time it requires to attain this temperature varies much according to the size and design of the machine. There is, in the proper sense, no accumulation after this point is reached, the rise of temperature after stopping being due to the fact that the capacity for dissipating heat is greatly reduced by the stoppage, that the flow of heat is therefore checked, and that the difference between the temperatures of the inside and outside are consequently diminished, the outside gradually getting hotter, until equilibrium between flow and temperature is established. The immediate effect of stopping is, therefore, to raise the temperature of the surface to something above its running temperature, but something under the temperature of the interior.

In designing machines, the field magnet coils are always made as short as the specified temperature limit will permit, but as regards the armature, conditions other than those having reference to heating may frequently operate to keep the temperature rise small. Generally, machines running at ordinary speeds, attain a temperature approaching the limits given, while running at slow speeds, high efficiency being maintained, the rise in temperature is much less. This means that the conductors in the latter case may have to be made so large to obtain high efficiency, that the temperature rise is considerably under the limit allowable.

If the heat generated in the armature winding, per unit of exposed surface, is to be constant, the current carried must vary as $d^{\frac{3}{2}}$ where d is the diameter of the conductor. The heat generated by hysteresis having to be got rid of, modifies in practice the application of this rule, as do also other conditions referred to in preceding paragraphs. To show how the currents and sizes of conductors are related in modern machines, the following table is given from the results of practice, the armatures being in all cases Gramme wound.

Ampères.	Size of wire.	No. of layers.
5·0	·048″ diam. single	4
7·5	·062″ ,, ,,	3
10·0	·075″ ,, ,,	3
20·0	·090″ ,, ,,	2
22·5	·075″ ,, double	2
25·0	·065″ ,, triple	3
32·5	·080″ ,, double	2
37·5	·126″ ,, single	1
40·0	·090″ ,, double	2
50·0	·109″ ,, ,,	2
50·0	·148″ ,, single	1
60·0	·180″ ,, ,,	1
75·0	·203″ ,, ,,	1
90·0	·238″ ,, ,,	1

It remains to be mentioned that the current density per square centimetre section in the magnet winding of ordinary machines comes out about half the current density in the armature.

(*To be continued.*)

M. E. MARES'S ELECTRICAL ENERGY METER.*

THIS apparatus belongs to the class of watt-hour meters with a periodic discontinuous integration. Fig. 1 enables us to easily understand the principle of its working. It comprises, like all indicators of this class, an apparatus for measuring the power, an apparatus for measuring the time, and a system for integrating the power in relation to the time. The measuring apparatus consists of two fixed bobbins with vertical axes mounted in the general circuit of distribution and a movable bobbin of fine wire placed in derivation at the terminals of the canalisation, the distribution being performed with a potential to all intents constant. The movable bobbin is influenced from above by the united action of the two fixed bobbins, and the force brought to bear upon it is at each moment equal to the product of the intensity of the current which passes through the fixed bobbins by the intensity of the current passing through the movable bobbin, *i.e.*, to the power, E I, supplied to the circuit, in virtue of the well-known principle of the watt-meter. This movable bobbin is suspended at the extremity of a horizontal lever, A B, the fulcrum of which is at *b*. Along this lever a carriage moves freely, its weight having been previously determined, and this moves the lever whenever its momentum in relation to the axis, *b*, attains a value equal to the momentum of the electro-dynamic force exercised between the bobbins in relation to the same axis. This carriage moves horizontally, changing its position on the lever, A B, by means of a wheel, M N, toothed on the inner edge of its rim and making one revolution in four minutes, and an inner wheel, O, bearing a number of teeth exactly equal to half that on the wheel, M N. Under these conditions we show kinematically that the point, *m*, describes a straight line, which is really the diameter, M N. This horizontal movement to and fro is transmitted to the carriage by the rod, T, which is fixed to it. The position of this carriage is so arranged that its course begins, starting from the extreme left, at the moment when its centre of gravity is exactly over the point, *b*. At this instant, the momentum of the weight is nil, and that of the electro-dynamic force of the bobbins preponderates. The carriage is drawn along from left to right rolling along the lever, A B. On its upper surface is a little rack which turns the first wheel, F, of the integrating dial of the meter in the opposite direction to the hands of a watch until the momentum of the weight in relation to the axis, *b*, exceeds that of the electro-dynamic force in relation to the same axis. The lever then moves at the same time as the carriage, the rack ceases to be in contact with the wheel, F, and its movement is stopped. We can understand that, during the movement, the wheel, F, has turned at an angle proportionate to the path described by the carriage on the lever during the whole of the period that the electro-dynamic action exceeded the force exerted by the weight of the tray; *i.e.*, at an angle proportionate to the power expended by the circuit at the moment when the movement of the lever, A B, is produced. The length of the path described by the tray is arranged so that its maximum displacement will counteract or even overpower the electro-dynamic action corresponding to the maximum power of which the machine is capable.

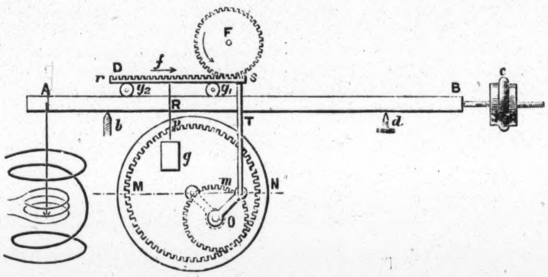

FIG. 1.—PRINCIPLE OF WORKING M. MARES'S METER.

In order to prevent the hands of the meter from going back during the return movement of the carriage, when the rack would turn the wheel, F, in the opposite direction, the current passing through the movable bobbin of fine wire is cut off during the half period occupied by the return of the carriage to its original position. The momentum of the electro-dynamic action being nil, the lever, A, B, remains at rest on its knife edge, *d*, and keeps the rack away from the wheel, F, during the whole of the period occupied by the return of the carriage. The same thing occurs periodically every four minutes; we can easily see that the sum of the angles described by the wheel, F, represents, by a quantity that is almost constant, the electrical energy supplied to the circuit during this period. This constant may easily be made to correspond with the unit, or one of its decimal multiples, by changing the total weight of the carriage, which can be effected with the greatest facility by placing regulating weights, previously accurately determined, in the little bucket, *g*, suspended at the centre of gravity of the carriage. Figs. 2, 3, 4 and 5 show different views of the meter, the principle of working of which we have just described, the mechanism having been constructed according to M. Marès's instructions by M. Déjardin. The clockwork movement is kept up by the current itself, and the winding up is effected during the half period of two minutes during which the current is cut off in the fine wire bobbin. The winding up is performed by sending in each half revolution five successive currents into the winding electro-magnet (figs. 2 and 3), by means of five friction contacts suitably placed on the principal wheel.

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* *L'Electricien.*

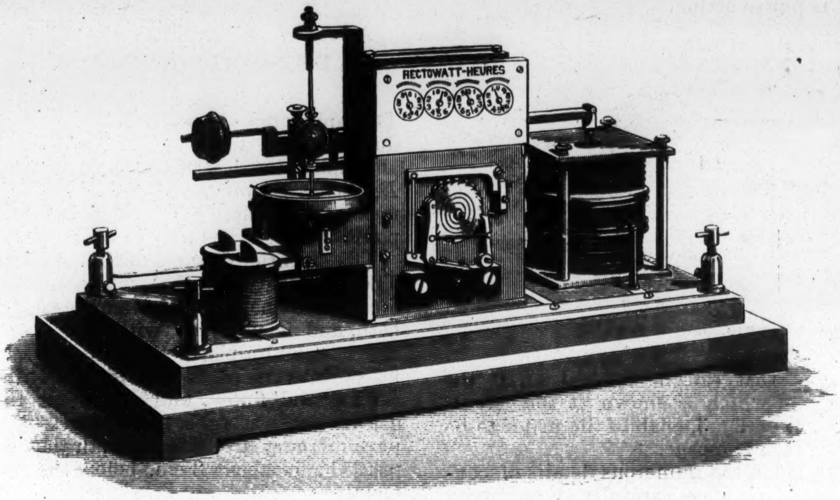


FIG. 2.

Front view of the meter showing the wattmeter, the conical pendulum, the winding mechanism, and the mechanism for stopping the conical pendulum and the integrating dial.

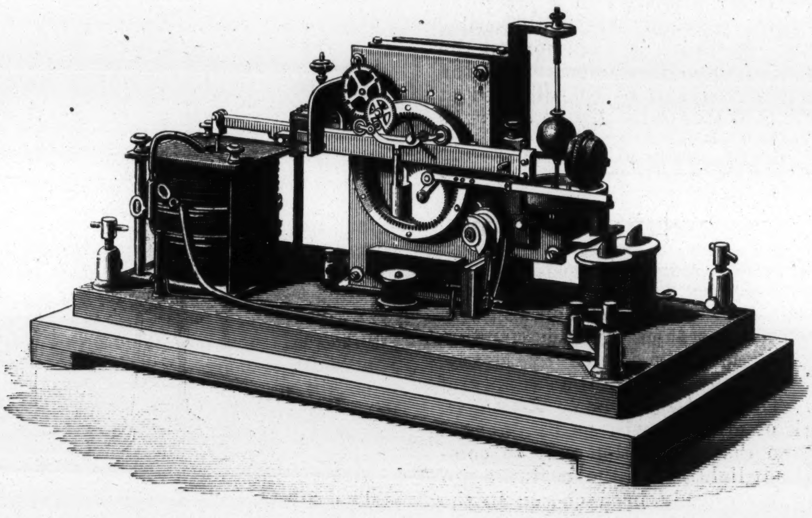


FIG. 3.

Back view of the meter, showing the wattmeter, the lever, and the integrating carriage, the hypo-cycloidal movement of the carriage, and the mechanism for stopping the conical pendulum.

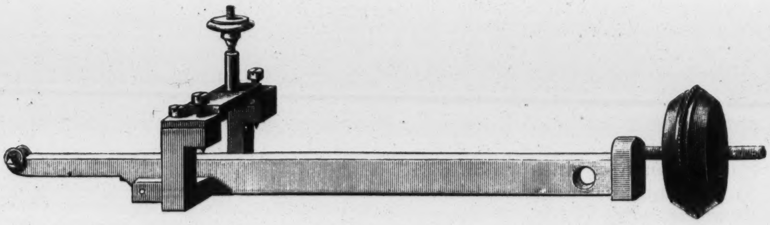


FIG. 4.

Each of these five currents winds the system up one tooth, and as during a complete period the spring unwinds to the extent of five teeth, it follows that the tension always remains to all intents the same, a condition which is essentially favourable to the regularity of the clockwork movement, regulated in this case by a conical pendulum, with the object of avoiding all vibration and shaking, the conical pendulum maintaining, by its very principle of action, a movement that is always uniform. This conical pendulum also serves to bring the meter to a level when it is installed, and also when it is put in action.

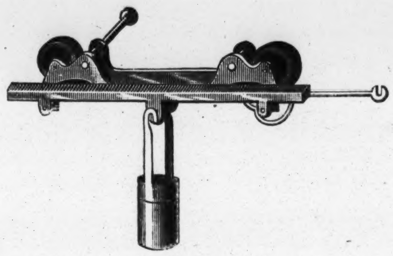


FIG. 5.

An electro-magnet that can be hooked on to the conical pendulum, and which is shown at the left of fig. 2, and at the right of fig. 3, enables the meter to be started at will after each stoppage.

Without dwelling upon the numerous details of construction, which have been most carefully studied both by the inventor and the constructor, we will merely remark that M. Marès's invention constitutes an absolute apparatus in which only those forces are introduced whose values are accurately known. As in the case of Mr. Walker's meter, described in a preceding number, and those which we shall hereafter describe, we will refrain from expressing any opinion on the practical value, if any, of these instruments until the experiments to which they are all to be subjected at the Municipal Electrical Works of the *Halles Centrales* are concluded.

THE COPENHAGEN CENTRAL STATION.

[FROM A CORRESPONDENT.]

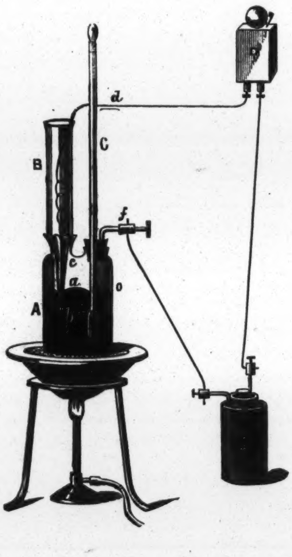
THE Copenhagen central electric light station, concerning the tenders for which a serious misunderstanding arose a short time ago, is to be erected by Messrs. Siemens and Halske for the simultaneous supply of 14,000 glow lamps. The *Elektrotechnische Zeitschrift* states that the work of erection will be commenced early in the spring, so that the station may be completed and ready to start lighting by the beginning of next winter. A site has already been chosen in the Gothesgade, which is situated in the centre of the town, so that the most remote point of distribution will only be 1,300 yards distant. The method of distribution will be the three wire system, which will be so arranged that the loss in E.M.F. between the station and the principal distributing points will be 28 volts, and from the latter to the lamps, 3 volts. The lamps will be of the 110-volt type, and the terminal pressure of the dynamos will therefore have to be 251 volts. The mains will consist of the well-known Siemens armoured cables. The generating station will contain seven tubular boilers of 235 square metres of heating surface, and three compound steam engines which will be coupled direct to six dynamos, each engine driving two machines. The total capacity of the dynamos, which will be of the internal pole type and connected two in series, will be 611 kilowatts.

In order to avoid the running in the daytime of any dynamo or dynamos at less than full load, there is to be installed a battery of 272 Tudor accumulators having a discharge capacity of 250 ampères. Future extensions in the output of the station will be effected by increasing the number of accumulators, and for this purpose a four-storeyed building will be erected adjoining the station and capable of containing sufficient cells to supply 14,000 lamps. In case of a further enlargement being necessary, it is proposed to erect accumulator stations in the suburbs where the cells would be charged direct from dynamos of a higher tension than those to be at first installed.

A NEW ELECTRICAL APPARATUS FOR DETERMINING MELTING POINTS.

THE apparatus shown in the accompanying sketch is due to the ingenuity of A. C. Christomanos, who gives an elaborate description of it in the *Berichte der Deutschen Chemischen Gesellschaft.* He claims that by means of it a more correct determination of the melting point of substances may be ensured.

The essential features of this apparatus is as follows: The cylindrical vessel, A, which is 12 cm. in height and 6 cm. in diameter, is heated on a sand bath or in an air bath, and is provided with two apertures; a thermometer, C, and a platinum wire, *f*, pass through a cork fitting into one of the apertures, whilst the other, *c*, is conical and fluted, and serves for the reception of a drawn out test tube, B. The vessel, A, is filled with pure mercury to such a depth that the end, *b*, of the test tube is about 2 cm. below the surface, *a o*, of the metal.



The substance is introduced in a melted condition into the end, *b*, of the drawn out test tube, so that it forms a layer of from 0·5 to 1·5 cm. in length, and when it has completely solidified again the test tube is placed in position, and the space, *a c*, immediately above the substance filled with mercury, into which dips the platinum wire, *d*.

On applying heat, the mercury in A is uniformly heated throughout its whole mass, so that the thermometer and the substance are always at the same temperature; the moment the substance melts the two mercury columns come in contact, the circuit is completed, the bell, D, rings, and the temperature is noted.

Fire Caused by an Electric Wire.—The *St. James's Gazette* had on Monday a sensational paragraph as to a fire caused by an electric light wire in the Grand Café, Boulevard des Capucines, Paris, on Saturday night. Shortly after 9 o'clock the lights went out, and a strong odour of burning India-rubber was perceptible. The woodwork in the cellar began to burn, and in a very short time flames appeared from the windows. Before the current was turned off and the fire extinguished considerable damage had been done.

TELE-PHOTOGRAPHY.

By HENRY SUTTON.

UNDER various names the problem of transmitting optical images by aid of the telegraph wire has at different times had attention drawn to it.

In putting forward something new in this direction, I will begin by inventing a new name, and propose calling the subject Teleph*a*ny, and the electro-optic instrument the Teleph*a*ne.

The art of telephony is simple compared with that of teleph*a*ny. In the former we deal with a consecutive series of waves of varying rate and length, and it is the consecutive character of sound waves that lends itself so admirably to electrical translation.

In teleph*a*ny we are met, at the outset, with a great preliminary difficulty, having to deal with a surface or plane in which the effect appealing to the brain must be observed in all the varying character at one and the same time.

The problem stands thus: a means has to be devised whereby the varying effects on a plane surface are translated into consecutive series of electrical currents, and by means of the consecutive series of currents reconstruct, so to speak, a copy of the original surface; that is, we have to take an optical image, seen as a *surface*, translate it into a *line* of consecutive varying electrical currents, and by means of these produce an effect as a *surface*, having the characteristics of the original image.

We have here two images as surfaces having no time value, and a series of electrical currents having a time value, yet these opposing characteristics are to be presented to the brain as a momentary impression.

Before showing how this apparently impossible problem may be handled, I will explain a probable means for electrically transmitting a photograph.

If we make what photo-mechanical operators call a *screen* negative of a portrait, using a coarse screen, and from this a photo-lithographic transfer, transfer it to zinc, and transmit the result by any of the several autographic systems, we have the desired result. In fact, if we apply our knowledge of *half-tone block* making to telegraphy, we are at once in possession of a means of electrically transmitting the photographic semblance of any person.

We may make a *screen* negative, and from that obtain a print on zinc or copper coated with sensitive albumen or bitumen, using the usual solvents, water or turpentine, as the case may be, with which to wash away the unexposed albumen or bitumen, then let the stylus of any autographic system traverse the developed image, the result at the receiving end is a facsimile portrait. I have used the expression *screen negative*, as it is an understood trade name; as a matter of fact, a *screen positive* would be necessary. We may go further, instead of receiving the facsimile on chemically-prepared paper, as in the Caselli autographic telegraph, we can make the receiving stylus perforate thin paper (with the electric spark) by means of a constantly-working induction coil, but only put into the receiving circuit by the transmitted current. Place this paper on a lithographic stone or zinc plate, pass a roller charged with greasy ink over it, and we have a *printing surface*, the portrait being *transmitted and reproduced for the printer*, photo-electro-mechanically.

But this is not teleph*a*ny; the latter must be understood as the means of transmitting images which may be in motion, as seen in a photographic camera, but not in colours.

Having spent some years in studying the problem, I designed the following system five years ago, as my Victorian scientific friends can testify. It may be of much assistance to workers in this direction. I think it offers a fair approximation to the solution of this very difficult problem; at any rate, if in its present form it is not the actual solution, I feel sure it is in the direction indicated by my method, that the successful accomplishment of teleph*a*ny will result.

Transmitter.

L (figs. 1 and 5) is a photographic objective of the rapid type, producing an intensely illuminated aerial image at A A.

D D (figs. 1, 2 and 5), light metal disc revolving at a fixed rate of not less than 650 revolutions per minute under the control of La Cour's phonic wheel and fork apparatus as in the Delany multiplex system.

G (figs. 1, 3 and 5), a glass or other insulating plate, to the front surface of which is held, by binding terminals, S_1 S, two triangular pieces of metal just separated from each other, E E.

C (figs. 1, 3 and 5), a small piece of lamp-black, selenium or other substance, the resistance of which may be varied by heat or light. Lamp-black compressed is probably the most suitable.

The disc, D D, has a series of small holes, 1, 2, 3, 4, 5, 6, 7, 8, perforated in it, and gradually approaching its centre, as a spiral, these holes must be numerous, and yet only one at a time in the field of the image at A A.

R L (figs. 1 and 5) is the most important part of the transmitter. This I term the regulating lens; it is a lens placed with its plane surface just to receive the aerial image from the objective L, its focal length being such as to bring all rays reaching it through the perforated disc to a point or focus at C, and therefore its function is to introduce them consecutively to the circuit comprised in S_1, E_1, C, E, S.

Under the influence of this regulating lens the whole image, A A, is allowed to act in consecutive manner, and therefore vary the resistance of C in accord with the lights and shades of the original. We thus solve the big problem of translating the plane image into a line of consecutively varying strength of current, and by bringing C under the influence of the whole image within one-tenth of a second, and during the same time reconstruct our image at the receiving station, persistance of vision will enable us to see the image as one impression.

Receiver.

S_1 (figs. 4 and 5), any artificial source of light, a beam of which is by means of lens, L, passed through a pair of Nicol prisms, P, A, this beam reaching lens M_1, is magnified and received by the eye-piece, M, M, and viewed by the eye, E. It is absolutely requisite this beam be received by the eye through optical means. The presence of a translucent screen at X, X, would be fatal, owing to the delicate nature of the desired effect.

D D (fig. 4), is a perforated disc, similar to and revolving synchronously with the disc in transmitter.

K K (figs. 4, 5 and 6), terminals inserted in glass and having a small space between, holding a drop of bisulphide of carbon, S.

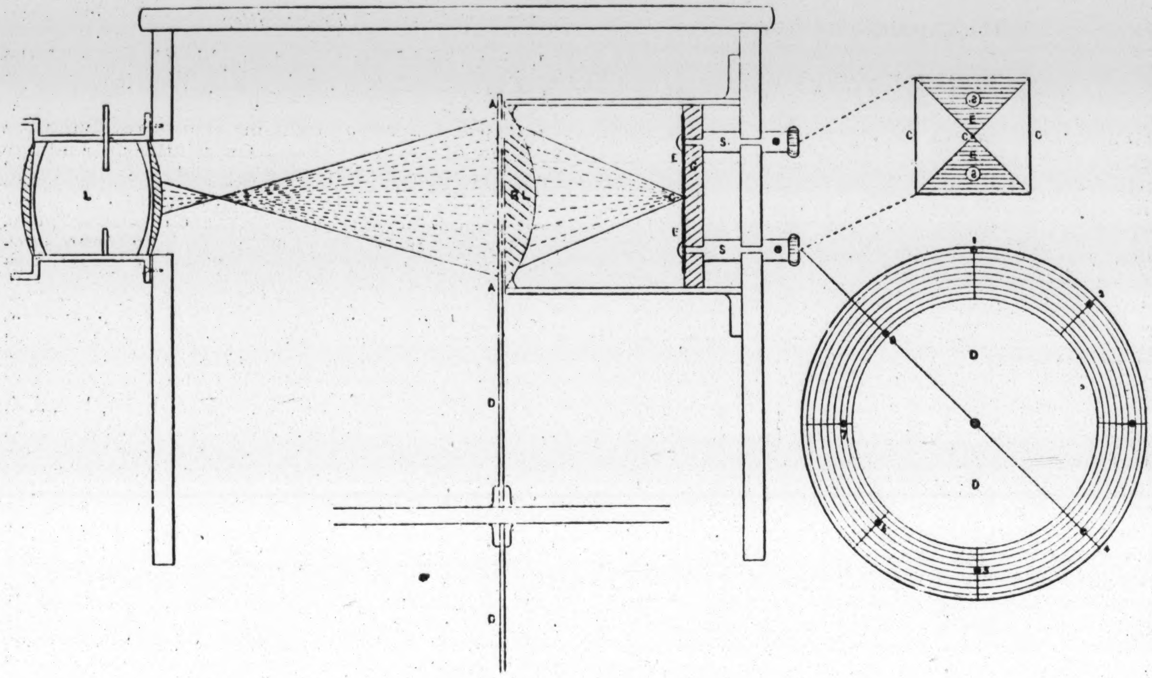
On rotating the Nicol, P, 45°, we reach the position of extinction.

The terminals, K, K, being placed in the secondary circuit of the transmitter—that is, to line—the variable electrostatic strain produced in the drop of bisulphide of carbon under the action of induced currents received from transmitter, is to produce variable rotation of the polarised beam, and, therefore, variable quantities of light reach the eye, E.

It is obvious the varying tints will be seen in similar position as in original image, owing to the synchronous movement of the discs.

The receiver is, then, based on Dr. Kers's discovery of the rotation of a plane polarised beam of light, through electric stress producing a strain in the medium.

There seems to me no question that the electric impulses will do their work within one-tenth of a second, and the point is whether the stress at O O will be sufficient to produce an observable effect, and whether this may be increased by passing the light through a bisulphide of carbon cell having a longer path of, say, $\frac{1}{16}$th inch diameter, as shown at fig. 6, instead of through the drop of bisulphide; so that, conceding the teleph*a*ne is based on a rightly conceived principle, it becomes a



FIGS. 1, 2 AND 3.—TRANSMITTER.

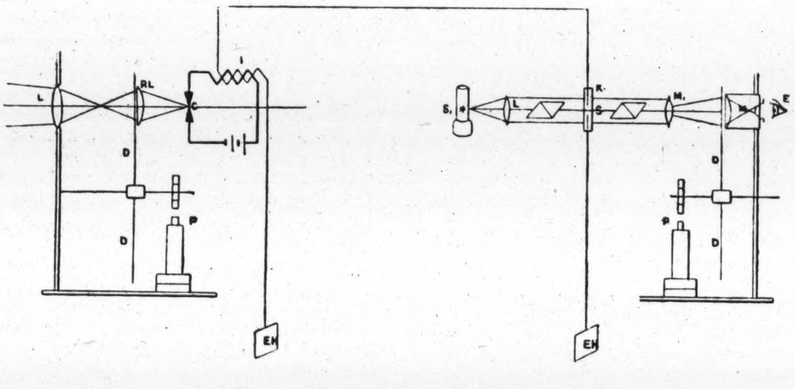
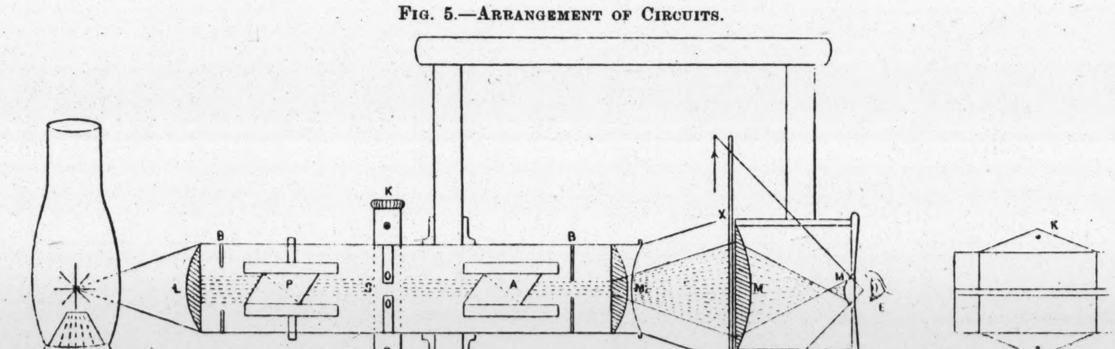


FIG. 5.—ARRANGEMENT OF CIRCUITS.



FIGS. 4 AND 6.—RECEIVER.

question whether the quantitative results of the physical effects utilised in its design are sufficiently great.

I think the transmitter may be considered as near the right thing as the present state of our knowledge will admit us to reach; there is an appearance of finality about it.

With regard to the receiver it is a question of degree; the actual quantity of light required to reach the eye may be very small when received optically; in fact, so small as to have no power of illumination on a translucent screen; but a quantity of light producing no visible effect on any media, when received by means of an eye-piece shows a bright disc. Owing to being away from references, I regret my inability at the moment to give the name of the inventor of the revolving disc; with the exception of these discs the whole design is original, and was devised at Ballarat, Victoria.

INDUSTRIALISM.[*]

By W. B. ESSON.

When the Old Students' Association did me the honour to nominate me as President, I mildly suggested that by way of innovation this address might be dispensed with. The committee received that proposal, however, with open derision. Individually and collectively it smiled while declaring that the suggestion had been made before, annually in fact, and just as often as a president had been nominated. The committee remaining inexorable, the serious business of choosing a subject had to be considered, and I may confess that considerable difficulty was experienced in the selection. One does not want to talk as a specialist on such an occasion, as the address can then interest but a few. One wishes, if possible, to say something in which all the members will feel some interest, notwithstanding the diversity of the pursuits in which they may be severally engaged. And surely there is in their occupations plenty of variety. The Old Students' Association includes among its members men occupying positions in every department of applied science. In the numerous branches of civil and mechanical engineering, in departments devoted to the several applications of electricity, and in most of the great chemical industries we find the Old Students' Association represented. And this, I believe, is common to most of the representatives, that each in his particular sphere strives with might and main to achieve success.

But whatever branch of industry we may be engaged in, at some time or other we have attended the classes for technical instruction, conducted under the auspices of the City and Guilds of London Institute. It may have been for a long or short period at the Central Institution, at the Finsbury Technical College, or in a subterranean chamber in Cowper Street before either of those places was built. Anyhow, the scattered members of this association, with their many diverse interests, are united by the bond of that old studentship and the memories which cling around it. True, we can boast of no ancient pile or venerable quadrangle echoing the voices of the past, but if we are without the historical associations and traditions of an ancient university, we are at least free from its "dead languages and its undying prejudices." We are distinctly with the moderns. We went in for a liberal education, and for such preparation as was rightly or wrongly conceived to best fit us for rising to a place from the ranks of modern industry. Our object was to win, if possible, in the industrial struggle—in short, to make a living.

And here, I think, we touch common ground. We are all engaged in fighting, with more or less success, the battle of life. We are all performing some function in the world of industry. We are all trying to make a living. In endeavouring to find a suitable subject for my address these reflections occurred to me, and it then struck me that I might occupy your attention for a short time with the all-important subject of Industrialism, a topic of vast interest to all classes of the community, since it involves problems the solution of which is becoming pre-eminently *the* question of the present as it will be that of the future.

Industrialism is a growth, and the present highly specialised methods of production have been evolved gradually from the ruder processes of the past. In savage communities there was no variety of individual occupation. By turn a warrior, a hunter, a fisherman, a tool maker or builder, each lived independently of his neighbour, concerted action only being taken for the purpose of defence. But in time, individuals showed special aptitudes for particular kinds of work. Some displayed special abilities in making weapons, while others, more intrepid and courageous, showed a more decided inclination to use them. In a sort of understanding that the men who made the weapons would be furnished with food by the hunters who used them, we can easily understand a crude division of labour to have had its origin. From a remote savagery through the ages which elapsed before men began to learn much of the arts of civilisation, the principle of the division of labour continued to develop the skill afterwards directed towards the arts of civilisation, being first engendered and fostered by the arts of war. "If we go back to the Stone Age," says Mr. Herbert Spencer, "we see that the implements of the chase and the implements of war are those showing most labour and dexterity. If we take still-existing human races which were without metals when we found them, we see in their skilfully-wrought stone clubs, as well as in their large war canoes, that the need of defence and attack were the chief stimuli to the cultivation of arts afterwards available for productive purposes. Passing over intermediate stages we may note in comparatively recent stages the same relation. Observe a coat of mail or one of the more highly finished suits of armour—compare it with articles of iron and steel of the same date; and there is evidence that these desires to kill enemies and escape being killed more extreme than any other, have had great effects on those arts of working in metal to which most other arts owe their progress. Indeed, it may be questioned whether in the absence of that exercise of manipulative faculty which the making of weapons originally gave, there would ever have been produced the tools required for developed industry."[*] But in addition to fostering industrial art, war slowly brought about the conditions which made an industrial state of society possible. It was by force of arms that small nomadic hordes were welded into large tribes, that tribes were welded into small nations, and that small nations were welded into large nations. Only by the social aggregation arising from warfare were produced the conditions under which the division of labour could be developed to any considerable extent.

Contemporaneously with the development of industry grew the distinction which gradually became more emphasised between the regulating and the regulated classes. In primitive tribes the chiefs worked like other members with their own hands, and were only distinguished from them by more than usual valour exhibited in attack or defence. All fought when the need arose, and the separation of the chief from the rest of the tribe, his ceasing to work with his own hands, his gathering around him warriors distinguished by their valour, his dividing amongst them the lands of conquered races, the rise of feudalism, its ultimate decay and the advent of wage-paid labour were amongst changes which the slow roll of centuries gradually brought about.

Coming to the Middle Ages, we find the arts of civilisation considerably advanced; towns growing and Industrialism advancing as militancy decreased. The oppression of feudal lords pressed hardly, however, on the growing industries, and labour was burdened with heavy taxes to maintain large numbers of military retainers in a state of idleness and comparative luxury. "The old freemen formed their Frith-Gilds against the tyranny of medieval magnates,"[†] and to defend themselves against the extortionate demands of lawless barons who were continually waging war against each other and levying the cost of their "expeditions" on the struggling industries. The history of those old-world combinations is extremely interesting reading, but here we have no time to do more than mention their existence; we are only skimming over their history in order that we may more completely realise that the present is unquestionably born of the past.

"So long as the towns were struggling against adversity, all the citizens worked together with public spirit and enterprise to secure their common welfare, but when a town had fully achieved its freedom and began to prosper, the oldest families of traders began to insist on their own privileges as the only proper full citizens and as members of the Town Gild."[‡] While it was necessary they welcomed the combination of the craftsman against their common enemies, but as the need for such combination diminished, the aggressiveness they manifested against their inferiors increased. To resist the pretensions of the old burghers, those who worked at different trades accordingly formed themselves into craft-gilds, and for many generations the struggle between the two classes was carried on. But at length the victory was gained by the younger and more vigorous combinations of handicraftsmen. "In one town after another the craft gilds, leagueing together, overthrew the town gilds, and obtained mastery of the town,"[§] governing it afterwards in their place for many generations.

In early times comparatively little capital was required for production. Industry was carried on by hand labour, and there was no expensive machinery to purchase and keep in repair. Then, the advantage of gathering many workers under one roof had no existence, and employer and employed were practically on the same level. Each craftsman worked with his own hands and in the same room with his workman, being aided by two or three hired journeymen and an apprentice, who became in course of time a craftsman himself. The relation of master and servant was, in those days, almost patriarchal in its character. The man was brought into close contact with his employer daily and hourly, and the identity of interests was recognised by both, for the class war between capital and labour had not as yet commenced. Again, good work was done in these old days. The gilds took care that only capable craftsmen should be permitted to join their association, and the standard of work was well kept up. They were charitably inclined, and insured the worker and his family against want in case misfortune overtook them. While their influence lasted, the gilds were in many ways useful, but they had their day, and a time came when the attempts to regulate trade, and the various restrictions they imposed on industry, became harmful. Then came a reaction, and the gilds had to go, as have all institutions which lack the power to adapt themselves to a changed condition of existence. They lost their influence; advancing industry would not be restrained in the old grooves, and the gilds refusing to yield, it forthwith burst the barriers they had set up, and moved on in spite of them.

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[*] Presidential Address delivered to the Old Students' Association of the City and Guilds of London Institute at Finsbury College, November 6th, 1890.

[*] Herbert Spencer, "The Study of Sociology," page 194.

[†] Brentano's "Introduction to English Gilds," page 195.

[‡] Marshall's "Economies of Industry," page 46.

[§] *Ibid*, page 46.

I have said that in early times there was little difference socially between the craftsman and his journeyman. But time brought a change in this respect. The craftsmen prospered, and their savings accumulated; capital began to grow, and the gulf between master and man, which was at first an almost imperceptible fissure, gradually widened. The former had grown rich, and had ceased to work with his own hands, or associate with his workmen. As his wealth grew, he employed more labourers, whom he treated in much the same way as he himself had been treated by the old burghers in former times; and in combining to protect themselves against the aggression of the rising capitalists, the workmen followed the example set by the craft gilds when they resisted the claims of the frith gilds. So we see that there is manifested the same kind of tendency all through the history of industry. Nor is the reason far to seek. While tribes were engaged in constant strife, Industrialism was born and nursed in the lap of warfare. The arts were cultivated chiefly as a means of defence against the inroads of enemies or of conquering neighbouring tribes. Men were barbarians, and their adaptation to the restraints imposed by their living in the society of others had scarcely begun. Through centuries of warfare, of violence and bloodshed, Industrialism slowly struggled, civilisation progressing painfully and only as fast as savage hordes settled down to peaceful occupations. But though warfare nursed Industrialism, consolidated scattered tribes, and by its discipline converted a savage incapable of continuous application into the man who, as a citizen, works from morn till eve, it left, alas! its bitter traits behind. In early times every member of the tribe was a fighter, and only slowly was the separation at first partial, between soldiers and citizens accomplished. The latter were liable to be called upon for military service, for a long period, and when the separation was complete it was a soldier who had become a citizen. A soldier, inasmuch as he or his ancestors had been trained in cruelty, disciplined in butchery, had been schooled in treachery, and had revelled in bloodshed. And with this inheritance from the past, bearing in mind how slowly human nature changes, and how very gradual has been the process of adaptation to the social condition so far, is it any wonder that citizens should have manifested, though in a less degree, the aggression and the cruelty, and the persecution of former ages? Is it matter for surprise that Industrialism should have displayed to a large extent the character of the militancy from which it was developed?

But we come now to the end of the seventeenth or beginning of the eighteenth century, when began that new era of steam, by which the world has been revolutionised. It was for pumping the water out of mines that Thomas Savery, in 1698, took out his patent for an engine to raise water by fire. I need not describe this engine, which to most of you is probably well known. As a pumping engine it was of course very inefficient, its duty being something less than one-tenth that of a modern one. But there is one thing I would mention here as illustrating the opposition at that time to the introduction of any appliance which appeared to dispense with hand labour or render a less number of workmen necessary. In a letter addressed to the "Gentlemen Adventurers in the Mines of England," Savery apologises, in a measure, for his invention, saying, "As for pump making, that part of the trade will be much improved by my engine, for I must use board and timber for pipes, and have considerable employment for pump makers and carpenters for timber used about my engine. For my design is not in the least to prejudice the artificers, or, indeed, any other sort of people by this invention, which, on the contrary, is intended for the benefit and advantage of mankind in general." This language from an inventor implies the state of feeling at the time with relation to labour-saving devices. In 1712, an improved pumping engine was erected at Wolverhampton, by Newcomen and Cawley, who gave us the beam to be found in the modern type. Following Newcomen, we had Smeaton and others, who made great improvements, but it was left for the genius of Watt to make, from 1769 to 1782, those radical changes which have stamped the great inventor for all time as the father of the modern steam engine. At first, his engine, like previous ones, was used only for mining purposes; but soon he invented his methods of converting the reciprocating motion of the beam into the rotatory motion required for working machinery. For the pump rods were substituted the connecting rod, with its sun and planet wheels; the steam engine was thus rendered applicable to any purpose of industry, and became the greatest power for good—some would say for evil—the world has ever seen.

In the middle of the eighteenth century, the industries of the country were carried on, to a large extent, in the homes of the operatives. In the first stage of cotton manufacture, for example, the weavers, dispersed in cottages throughout the country, wove their webs from yarn spun by their wives and children on the common hand-wheel or distaff. At the same time, the weaver cultivated a small patch of ground, and, to us living midst the moil and toil of this nineteenth century, the picture of domestic industry and family life, thus presented, is very pleasant to dwell upon. Honest John Ruskin, whose heart in matters of political economy is very much better than his logic, may not be quite alone in lamenting the gradual extermination of those rural workers. Rut lamentations are worse than useless. The system of those days represented but a phase in the history of industrial development, it disappeared to give place to another, it was but transient as is indeed the system of our own times. Distance is apt to lend here, as elsewhere, enchantment to the view, and it is not unlikely that the workers' lot in those days was, taking all things into consideration, harder than it is now. In 1767 the spinning jenny was invented by Hargraves, and a few years later, Arkwright constructed spinning frames in which were utilised Wyatt's, Paul's and High's inventions for spinning by rollers, To work these new machines water-power was employed, and from this period dates the rise of textile factories. "For several years," says Mr. Redgrave in his report for 1875, "the textile industry was carried on in the rural districts only. . . . Water on the hill sides was irregular in its flow; work was therefore irregular; when the stream was full, work was brisk (we should have called it excessive); when it was dry the factory hands were employed on the lands in haymaking, or other like occupations. Thus the operatives were both farm labourers as well as factory workers; and as manufacturing was not the complicated affair that it is now, they were free from many evils which afterwards arose from the introduction of steam and the immense energy and enterprise of our manufacturers." The application of steam to the working of machinery created the factory system proper. Inventors had not been idle, and numerous improvements had been effected in several directions. Cartwright had invented his power loom in 1784, and in 1785 Boulton and Watt erected in a factory at Papplewick the first steam engine applied as the moving power for spinning machinery. Progress was now rapid, and in every department of industry invention was producing new improvements. The rising seats of industry had been connected with each other and with the sea by canals. Large steam factories were erected, and tempted by higher wages and the promise of constant employment, armies of workmen came to fill them from the rural districts. Capital now became a huge power in industry, and very soon occurred the opening skirmishes of the labour war which has continued ever since.

If we are to believe the writers of this period the miseries following upon the introduction of the factory system were very great. In many cases the capitalists made a bad use of their power. "They crowded their factories with apprentices, many of whom they took from the parish with a premium of £5 each. The factories were so unhealthy, and the children worked so hard and for such long hours, as to be seriously injured physically and morally."* In the report already referred to, Mr. Redgrave calls attention to the bringing together, without previously providing adequate and proper means for accommodation, hundreds of families to fill the mills. "Then followed immediately the proneness to run the costly machinery, regardless of the waste of human life, health, and happiness for any number of hours that seemed good to the capitalist. The factory population appeared in time to have become a distinct race that was known at a glance, so defined were the effects of overwork and unhealthy dwellings upon the physical appearance and condition of the people." Nor did the moral condition of the workers improve. Improvident and intemperate they appeared to go from bad to worse. Due to higher wages and the correspondingly easier conditions of existence, population increased rapidly. While, in fine, an increase of wealth took place in the capitalist part of the community, increase of numbers took place in the operative part. While gold was coined for the master, children were multiplied for his mills.

At a very early period the State had attempted the regulation of industry. In the time of Edward III. there was enacted a Statute of Labourers which attempted to fix the amount of remuneration each labourer should receive. It was intended to keep wages down, but notwithstanding from 1388 to 1444 they rose from 50 to 100 per cent. In the time of Henry VII. there was a law which directed people at what fairs to sell their goods. In the time of Henry VIII. it was made penal to sell any pins but such as are "double headed and have their head soldered fast to the shank and well smoothed, the shank well shaven, the point well and round-filed and smoothed." During the reign of Edward VI. a statute prescribed that a person making a usurious bargain should be fined £100. In the time of Mary and Elizabeth, laws were made limiting the number of looms each master weaver might have, and stating how many more apprentices than journeymen he might employ. In the reign of James I. a very wise Legislature prescribed the quantity of ale which should be sold for a penny.† Laws fixing the rate of interest and the wages of labour, prescribing the price of food and the shape of wearing apparel, specifying the goods to be made and the method of their manufacture were multiplied. In fact, there was in those days scarcely any limit to the duty undertaken by the State. Nor is this surprising when viewed in the true light of history. The citizens had inherited an unlimited belief in the power of Government. Primitive tribes could only be successful in war as their soldiers obeyed without question the orders of their chiefs. Those tribes in which the subordination was greatest would accordingly survive, while those in which it was less would in time be weeded out. It was the one necessity of the militant type of society that subordination to the chief should be complete, and faith in him entire. But the general in battle was also ruler during the intervening periods of peace, and to him the people looked to adjust their industrial quarrels, as well as to lead their soldiers to successful battle. Again, "success in war must largely depend on that conformity to the ruler's will which brings men and money when wanted, and adjusts all conduct to his needs."* Accordingly laws were made just as if industry, like armies, could be governed by force. The discipline of warfare had produced men whose nature it was to submit to control from rulers, and as Industrialism grew gradually out of the old militancy, men's natures changed but slowly in adaptation to the conditions of the newer règime. Somewhere between savagery and civilisation, partly industrial, partly military, society still believes the ruler all powerful. Every day the Government is petitioned to undertake some new work which it is assumed would be impossible of accomplishment by the community without its aid. Government may change its form, but the belief in its omnipotent character remains. Savage chiefs may be displaced by emperors and kings. Kings may delegate their functions to Parliaments. Parliaments may in time give place to Republican assemblies. But all through history the tradition of unlimited power clings to the rulers, nor will it disappear until man is completely adapted to the social state, and the last sign of militancy shall have disappeared.

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* Marshall's "Economics of Industry," page 188.

† See Herbert Spencer's "Social Statics," p. 313.

I have said that workers became demoralised under the factory system, and appeared to go from bad to worse. Accordingly, the Legislature undertook to set things straight. In 1802 was passed the first factory Act proper, which directed that "the rooms should be washed well with lime and water twice a year; that apprentices should be clothed with two suits yearly, and should be instructed in reading, writing, and arithmetic the first four years; that the hours of work should not be more than 12 per day, exclusive of meals, and that work might be carried on by night in mills with 1,500 spindles." The rapid development of the steam engine changed the conditions of labour in a short time to such an extent that the Act was no longer applicable, and so, in 1819 and 1825, we have further Acts restricting the hours of labour and the work of children. It may be mentioned that in the textile industries the apprenticeship system had by this time disappeared, as the skill requisite for handling the improved machinery could be attained in a very short time. These Acts were followed in 1831 and 1833 by further Acts relating to textile industries, but in 1834 the Legislature extended its scope, and passed laws influencing other classes of operatives. Accordingly, we had soon Acts of all kinds for the regulation of mines and collieries, print works, bleaching and dye works, bakehouses, copper and iron works, machine shops, fish curing and fruit preserving. In fact, there are so many Acts, that no one knows very well where we stand, and a Factory Enquiry Commission has had to acknowledge that this branch of our laws has become very unwieldy, and wants unification.† That these several enactments made the life of the workers somewhat easier for a time may be true. But that they have produced any true and lasting good, except in so far as they have removed hindrances to the natural growth of Industrialism, the student of sociology is at liberty to doubt. And there seemed to be some such doubt in the minds of the workmen themselves, for trades unions, formed at first to petition Parliament to pass measures in their behalf soon found that the aid they required was not forthcoming, and that they would have to "rely as the gilds before them had relied, upon their own energies. They no longer approached the Government with the purpose of inducing it to interfere in their behalf; but they petitioned and agitated for the cessation of Government interference against them." ‡ The conduct of the trades unions in the early part of the century was reprehensible in the extreme, and the opposition they manifested towards the introduction of machinery is a matter of history. It may indeed be doubted if working men have yet been intellectually convinced of the benefit of machinery. Anyway they had not been convinced in those days, and labour disputes were oftentimes accompanied by riots and bloodshed. By numerous Acts it had been made a crime punishable by fine and imprisonment to refuse to work for the purpose of obtaining higher wages, and "men who know they are criminals by the mere object they have in view, care little for the additional criminality involved in the means they adopt." However, trades unions have become more sensible, and one by one the combination laws have been repealed. The Legislature now recognises the combination of workmen for the purpose of bettering their condition as perfectly legal, provided that in carrying out their ends nothing is done by the combination which would be declared against law if done by an individual. The trades unions of to-day are in many ways analogous to the craft gilds of the past. They have for their objects, says Mr. Howell—(1) "to procure for their members the best return for their labour in the shape of higher wages, shorter hours of labour, and the enforcement of certain restrictions as to the condition of employment which could not be accomplished except by means of combination; (2) to provide mutual assurance for the members by means of pecuniary assistance in the case of sickness, accident, death, out of work, superannuation when disabled by old age, loss of tools by fire, and emigration.* These are principles with which no fault can be found, but, that they are often very superior to the conduct they are supposed to guide is a matter of everyday observation.

Well, gentlemen, these remarks bring me to modern times. Time has allowed me to notice only a few of the more important factors in the evolution of Industrialism. The growth of railways, the development of steam navigation, improvements in agriculture, electric telegraphs and submarine telegraphy, have each made enormous contributions to our industrial progress. But these by no means exhaust the list. It has been said that we of the nineteenth century are intellectually the heirs of all the ages, and not less true is it that present day Industrialism inherits a huge legacy from byegone centuries, has grown up by infinitesimal contributions of far away ages, as well as by the larger contributions of recent times. My history has been of a somewhat sketchy character, and the more so, perhaps, as here and there the narrative has been broken in the endeavour to emphasise the method of science in history. To thinking men, history is no longer a record of this or that sovereign's deeds, a chronicle of court intrigue or gossip of princely trappings. But it is the story of a nation's progress. It tells how institutions arise, flourish, and in time decay as new ones take their place. It shows how each successive stage of development arises from the one immediately preceding and gives birth to the one immediately following it. It recognises that the evolution of society proceeds in accordance with law, and that causation, though partially concealed by the extraordinary complexity of the phenomena to which it relates, must have here, as in all development, universal dominion. And so, as I have said previously, Industrialism is a growth, and the present methods of production have been evolved from the processes of the past. We have now huge factories employing thousands of workmen, and filled with self-acting machinery in which the division of labour is carried to the utmost limit. Whereas, in times past, it was necessary to spend years in serving an apprenticeship and learning several branches of a trade, in a great many instances the old apprenticeship system has been done away with, the whole of a lad's attention when he enters the factory being engaged in watching the one operation performed by an automatic machine. In all branches of the finished metal trades we are struck by the clever combinations of mechanism employed in the performance of the several operations, and as we watch machines rapidly doing their work with unerring precision, and requiring almost no attention, we may well wonder whether economy in production can go much further, whether adjustment of acts to ends can be rendered by mechanism more perfect. In the engineering trades similar division of labour is found and similar specialisation is apparent, though probably to a less extent. When I was an apprentice the old-fashioned millwright was not extinct. He was a man who could "put his hand to anything," as the saying is. He had served seven years' apprenticeship and could make his own patterns, forge whatever he needed, do turning and filing, and, on a pinch, might attempt brass-founding with metal melted over a smith's fire. He was a veritable Jack of all Trades, but he is no more. Modern industry does not require him and draws the line very distinctly between the several branches of the engineering trades. We have smiths who work forging machines and hydraulic press tools. We have turners, planers, slotters, shapers, drillers, millers and special tool men, each of whom has under his charge an expensive self-acting machine tool which it is his duty to look after and which it should be his aim to thoroughly understand. As Mr. Nasmyth says, "All that the mechanic has to do, and which any lad is able to do, is not to labour but to watch the beautiful functions of the machine."† In the shipbuilding trades the tendency towards specialisation is not less marked. In short, in every branch of industry the aim is twofold; first, to do as much as possible by machinery because hand labour is expensive; secondly, to restrict the function of the workman to performing one operation or to looking after one machine, because his whole thought being then concentrated on one thing, he soon acquires in his work special dexterity. The effect of the division of labour on the workman, when carried to excess, need not be here considered. On that point opinion is divided, some believing that constant employment, without variety, deadens a man's mental activity and resource, while others equally capable of judging hold that concentration on one operation sharpens a man's intelligence so far as concerns the sphere of his work, and gives him more opportunity for thought on subjects unconnected with his employment. However that may be, the division of labour is a great fact in modern industry, and as a means to economical production, there can be no question about its efficacy. The tendency is to carry it farther and farther, as concerns, by getting larger, are enabled to take the fullest advantage of the benefit it confers. It is the condition of production which Industrialism has by its natural development brought about.

But along with improved methods of production there has grown up within the century that vast distributive system which is represented by a railway capital of nearly one thousand millions sterling, and the direct employment of nearly half a million workmen. When we remember that these have to be fed, and clothed and housed; when we recollect that a large number of workmen must be employed in providing the iron and steel required in the manufacture of rolling stock, and that materials and labour must be constantly forthcoming for the construction of lines in progress; when we perceive that this distributive system, rendered necessary by increased production, has in its turn stimulated production to an incalculable extent, we begin to realise, though but faintly, how far-reaching in its influence on industry railway progress has been. Then we have—as constituting a farther means of distribution—docks, in the construction of which millions have been expended, and a huge mercantile navy which, by the direct and indirect employment of armies of workmen, enable us to effect an advantageous exchange of our goods for those of other nations. Ships have to be built, and workmen have to be supplied with the means of life in return for their labour. The raw materials must be furnished, and the necessary iron and steel produced by another host of labourers. Nor is this all, for outside the artisan classes indirectly depending on distribution for a livelihood, are thousands employed in mercantile houses, shipping agencies, and brokers' offices, all occupied in effecting the distribution of commodities, not to speak of the hundreds of thousands engaged in wholesale warehouses and retail shops. Meditating on these things, I say we begin to comprehend now vast, how complex, how inter-dependent in all its ramifications Industrialism has become.

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* Herbert Spencer, "The Man *v.* The State," p. 109.

† G. Phillips Bevan, "The Industrial Classes and Industrial Statistics." Textiles and Clothing, page 221.

‡ Marshall's "Economies of Industry," page 189.

* "The Conflicts of Capital and Labour," by George Howell, chap. III., section 45.

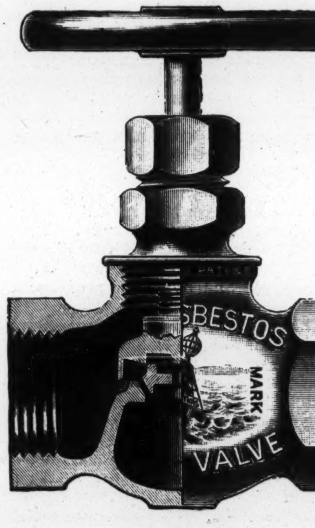
† Tenth Report of the Trades Union Commissioners, 1868, page 65.

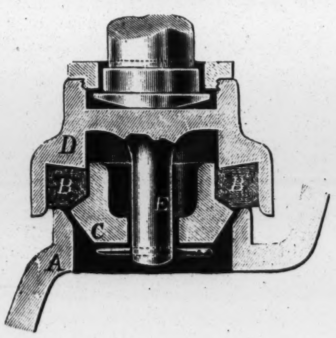
(*To be continued.*)

A NEW ASBESTOS-FACED VALVE.

WE venture to think the valve we illustrate will meet a long-felt want by supplying a flexible seating which can be renewed, if necessary, in a few minutes, by an ordinary workman at a cost of a few pence, and for which no special tools are required.

The lettered section and description we give will, we hope, enable its advantages to be clearly defined.





A represents the form of seat adopted in this valve which, in addition to the ordinary angled seat, has a round edge to prevent damage to the packing ring, B, when the latter is brought into contact with it.

D is a loose valve, actuated in the ordinary manner by a screwed spindle working in gland of the valve top, which, when first set down, brings the packing ring, B, on to the seat, A, and for ordinary pressures a perfectly tight and elastic joint is thus made, but, by setting the loose valve, D, hard down, the sliding cone, C, comes into contact with the angle of the seat, A, and being free on the guide stud, E, is forced into the chamber of the loose valve, D, and by compressing the packing ring, B, prevents it becoming damaged.

While the packing ring, B, is thoroughly protected by the lower projection of the loose valve, D, there is little tendency for B to become damaged by the passage of steam or water through the valve, but should it even become entirely washed out, a tight metal to metal seating is the result by A, C and D being brought closely together.

It is claimed that the valve through its elastic seating is not affected either by grit, dirt, expansion, contraction or uneven seating which makes it alike suitable for the highest or lowest pressures of steam, hydraulic, or general water valves by the insertion of packing rings made of the most suitable material to meet the various uses.

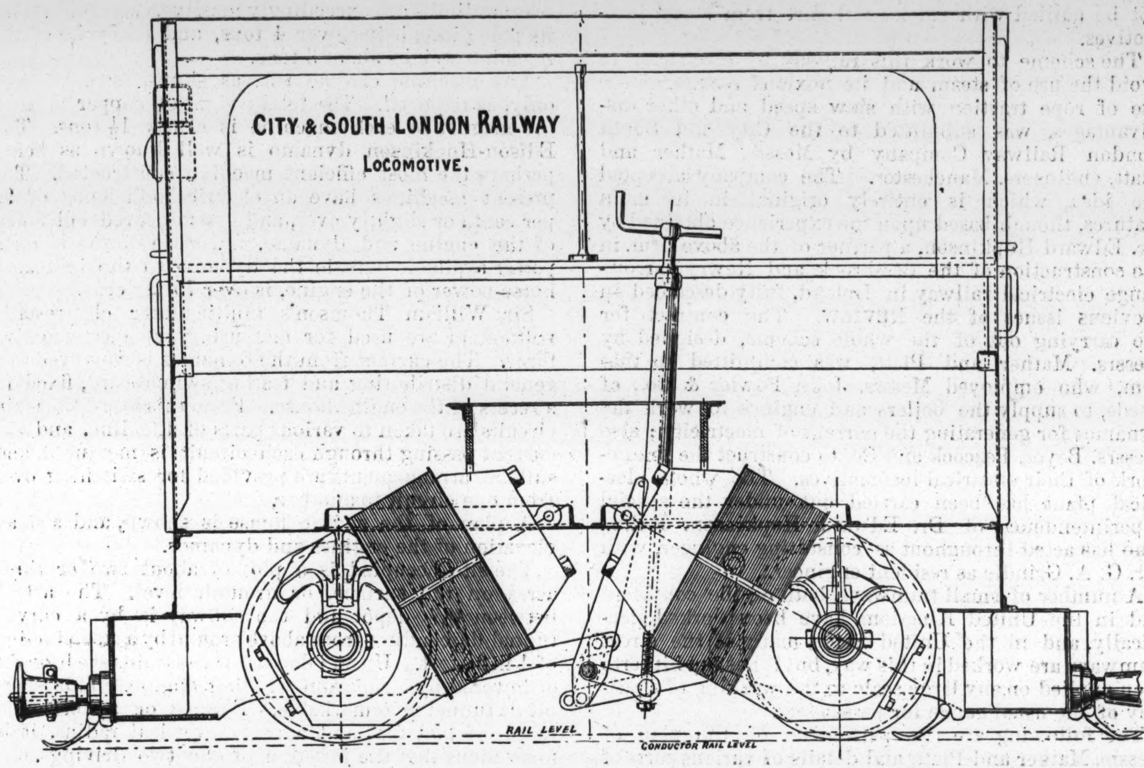
A 1½ inch valve, made under this patent, is said to have been under test for three months at a steam pressure of 100 lbs. per square inch and found to hold perfectly tight, after which it was put under hydraulic test, and by being lightly screwed down held a pressure of 2,240 lbs. per square inch.

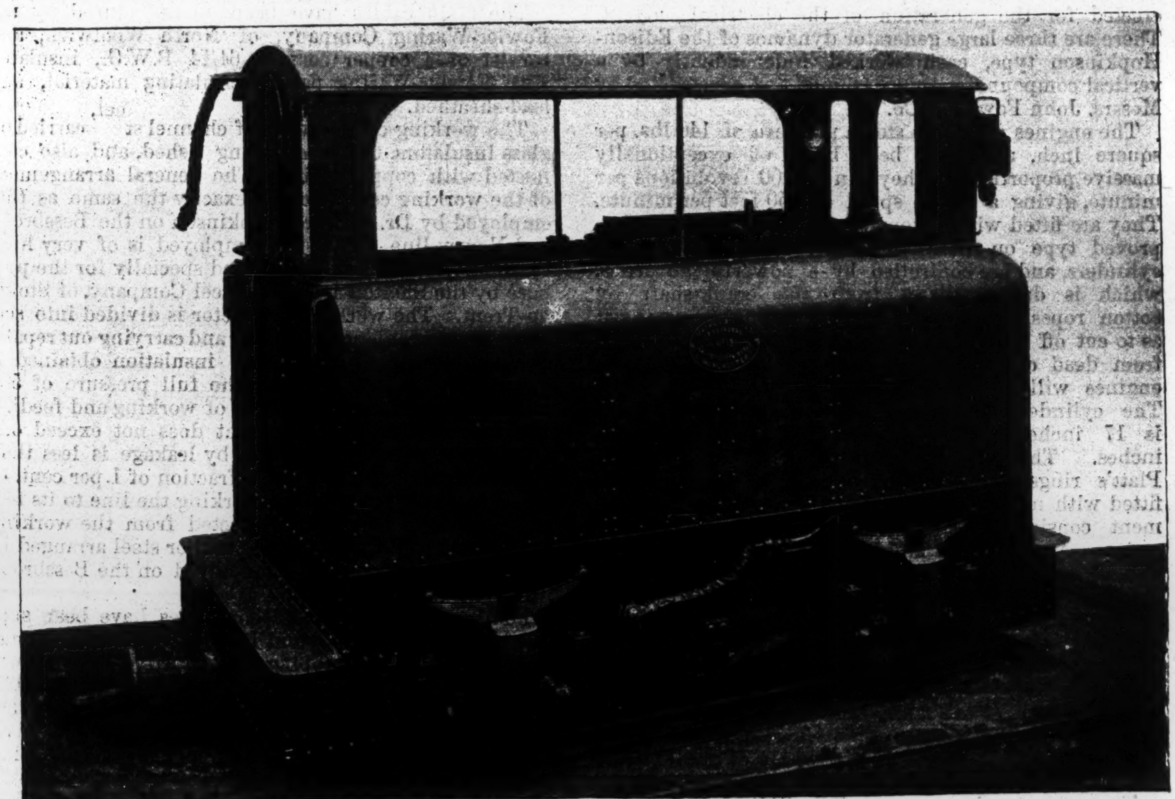
The packing ring used for these trials was made up specially in asbestos, and is still in perfect order, and we are assured it has not been removed at any time during or since the above trials.

THE CITY AND SOUTH LONDON RAILWAY.

THIS railway is a subway about 3½ miles in length, passing from a point in King William Street, City, under the Thames, and on to Stockwell, and constructed on a novel method, designed by Mr. Greathead, M.I.C.E., in the form of two circular iron tunnels 10 feet in diameter, driven throughout the London clay, about 60 feet below the surface, and at a cost of about £220,000 per mile.

The two tunnels, after having passed under the bed of the Thames, have been executed by the compressed air system, in the face of a subterranean difficulty which could hardly be exceeded—namely, a powerful underground river percolating through a gravel bed of large flints and coarse pebbles. This water-flow was kept back for weeks upon weeks by the sheer force of volumes of compressed air, whilst concrete and cement-grout were poured in front of the tunnel shield, and an artificial rock extemporised, in which the segments of the iron tunnel tube could be bolted together. For these and other engineering operations involved the just merit due to the resident engineer, Mr. Mott, should not be withheld. It is well further to note that the tunnels have been driven with exceeding accuracy and unrivalled speed. They were made in 400 yards lengths, 200 yards being driven from each face, and meeting like lengths driven from other faces. The extreme divergence of the junctions amounted in one instance only to seven-eighths of an inch, the others not exceeding a quarter of an inch, although the datum levels had to be transferred from the bottom of the shafts, which now contain the lifts, to the centres of the lines of tunnel, as the shafts were all on one side or the other of the line of railway. The rate of excavation was often as much as 16 feet per day, the average of the working days being 13 feet 6 inches advance of heading. All the anxieties of the engineering work are over, the rails of the road are laid, the platforms erected, and the neatly constructed underground stations, with their walls lined with white





View of Locomotive.

glazed tiles, are ready for the passengers, and have a cleaner and brighter aspect than any of the other underground stations in London. Moreover, they will not be sullied with smoke and dirt from steam locomotives.

The scheme to work this railway by electricity to avoid the use of steam and its noxious results, or the use of rope traction with slow speed and other disadvantages, was submitted to the City and South London Railway Company by Messrs. Mather and Platt, engineers, Manchester. The company accepted the idea, which is entirely original in its main features, though based upon the experience obtained by Dr. Edward Hopkinson, a partner of the above firm, in the construction of the Bessbrook and Newry narrow-gauge electrical railway in Ireland, fully described in previous issues of the REVIEW. The contract for the carrying out of the whole scheme, designed by Messrs. Mather and Platt, was committed to that firm, who employed Messrs. John Fowler & Co., of Leeds, to supply the boilers and engines to work the dynamos for generating the current of electricity; also Messrs. Beyer, Peacock and Co. to construct the framework of their electrical locomotives. The whole electrical plant has been carried out under the special superintendence of Dr. Edward Hopkinson, F.R.S., who has acted throughout as consulting engineer, with Mr. G. A. Grindle as resident engineer.

A number of small tramways, both on the continent and in the United Kingdom, have been worked electrically, and in the United States many of the street tramways are worked in this way, but it has not hitherto been applied on any large scale to the working of a railway of the usual gauge for passengers.

The following are the particulars of the plan of Messrs. Mather and Platt, and details of various parts of the work:—

The whole of the machinery for generating the electrical current is situated at Stockwell, the suburban terminus of the line. At this point a complete plant has been erected for the generation of the electrical current. There are three large generator dynamos of the Edison-Hopkinson type, each worked independently by a vertical compound engine, designed and constructed by Messrs. John Fowler & Co.

The engines work at a steam pressure of 140 lbs. per square inch, and have been built of exceptionally massive proportions. They run at 100 revolutions per minute, giving a piston speed of 450 feet per minute. They are fitted with automatic expansion gear of improved type on both the high and low pressure cylinders, and are controlled by a powerful governor, which is driven direct from the crank-shaft by cotton ropes, the automatic gear being so arranged as to cut off the steam if necessary in both cylinders from dead cut-off to three-quarters of stroke. The engines will indicate up to 375 horse-power each. The cylinders are steam-jacketted, the high-pressure is 17 inches diameter, and the low-pressure 27 inches. The pistons are fitted with Mather and Platt's rings and springs; the valves are specially fitted with multiple ports, which reduces their movement considerably, and still gives a very prompt action. As the parts are as close as possible to the end of each cylinder, the loss of pressure by wire drawing is very small. The flywheels are 14 feet diameter and 28 inches broad, and drive the dynamos direct by means of leather chain-belts 26 inches wide.

The engines are supplied with steam from six Lancashire boilers, 7 feet diameter by 28 feet long, which are fitted with Vicar's mechanical stokers. Two large feed water heaters are also supplied, with brass tubes of ample surface, for receiving the whole of the exhaust steam from the engine without back pressure.

The generator dynamos are of the Edison-Hopkinson patent type, with bar armatures, fitted with all the latest patented improvements of Messrs. Mather and Platt. The weight of the armature alone is about 2 tons, and the weight of the entire machine something over 17 tons. Each machine is capable of generating 450 volts and 450 ampères. The commutators are of hard copper insulated with mica, and there are three brushes on each rocking arm, each separately adjustable, with bring-forward thrust and hold-off catch. The magnet limbs are exceedingly massive, each limb, with its pole piece, being over 4 tons, and the yoke of the machine weighs about 3 tons.

The machine can be run as shunt, or compound only, as required. The total weight of copper wire on the magnet of each machine is nearly $1\frac{1}{2}$ tons. The Edison-Hopkinson dynamo is well known as being perhaps the most efficient machine constructed. The present machines have an electrical efficiency of 96 per cent., or slightly over, and the measured efficiency of the engine and dynamo, *i.e.*, ratio of the electric power available outside the dynamo to the indicated horse-power of the engine, is over 75 per cent.

Sir William Thomson's multicellular electrostatic voltmeters are used for measuring the electromotive force. The current from the dynamos is conveyed to a general distributing and testing switchboard, fixed in a recess of the engine house. From this board the main circuits are taken to various parts of the line, and the current passing through each circuit is measured, and suitable arrangements are provided for switching over from one circuit to another.

A plan of the engine house is shown, and also an elevation of the engines and dynamos.

The site occupied is a plot of about two or three acres on the surface, or ground, level. The access between this depôt and the subway is by a curved tunnel descending from above ground by a steep incline of 1 in $3\frac{1}{2}$ feet. Up and down this the trains are brought or lowered by a rope and winding engine. This short bit of tunnel is remarkable. Formed on a horizontal radius of 250 feet and a severe vertical radius, it is marvellous that the junction of the two drivings, one from below and the other from above, should have met centre for centre and level for level within an inch or two. At the depôt the carriage shed is large enough to contain six trains side by side.

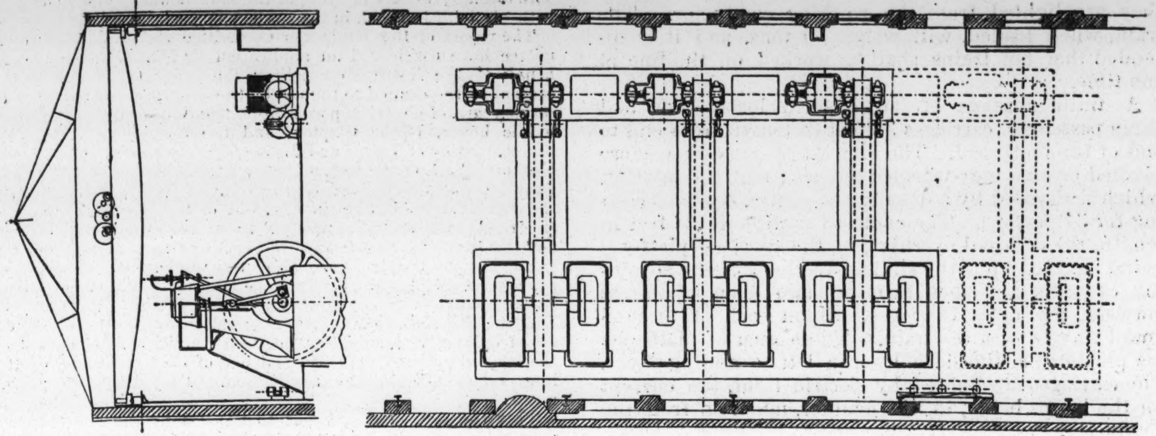
The main cables have been manufactured by the Fowler-Waring Company, of North Woolwich, and consist of a copper core of 61/14 B.W.G., insulated with Fowler-Waring patent insulating material, and lead-sheathed.

The working conductor is of channel steel, carried on glass insulators, the joints being fished, and also connected with copper strips. The general arrangement of the working conductor is exactly the same as that employed by Dr. Edward Hopkinson on the Bessbrook and Newry line. The steel employed is of very high conductivity, and has been rolled specially for the purpose by the Shelton Iron and Steel Company, of Stoke-on-Trent. The working conductor is divided into sections for convenience of testing and carrying out repairs on the permanent way. The insulation obtained is extraordinarily high. When the full pressure of 500 volts is on the complete system of working and feeding conductors, the leakage current does not exceed one ampère, so that the total loss by leakage is less than 1 horse-power; this is a small fraction of 1 per cent. of the total power required for working the line to its full capacity. The current is collected from the working conductor by sliding shoes of iron or steel arranged in a very similar way to that employed on the Bessbrook line.

Fourteen 10-ton electric locomotives have been supplied by Messrs. Mather and Platt for working the line, each capable of developing 100 effective horse-power and of running up to 25 or 26 miles per hour. The armatures of the locomotives are constructed so that the shaft of the armature is the axle of the locomotive, in this way all intermediate gear and all reciprocating parts are entirely obviated. The method was suggested by the late Sir William Siemens some years ago, but has not as yet been employed elsewhere. A motor is fitted on each axle, the axles not being coupled, but working quite independently. The current is conveyed from the collecting shoes through an ampèremeter to a regulating switch, then to a reversing switch, thence to the magnets and back through the framework of the

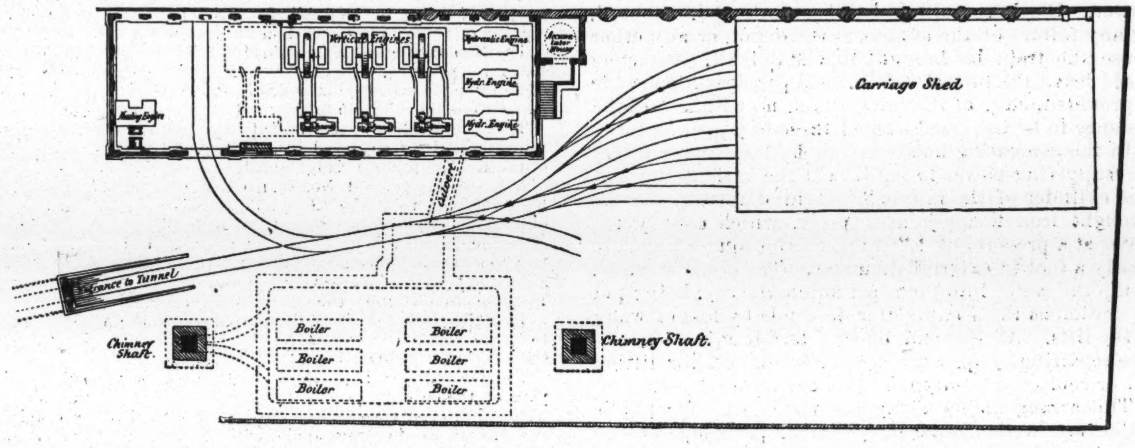
CITY & SOUTH LONDON RAILWAY

DYNAMO HOUSE



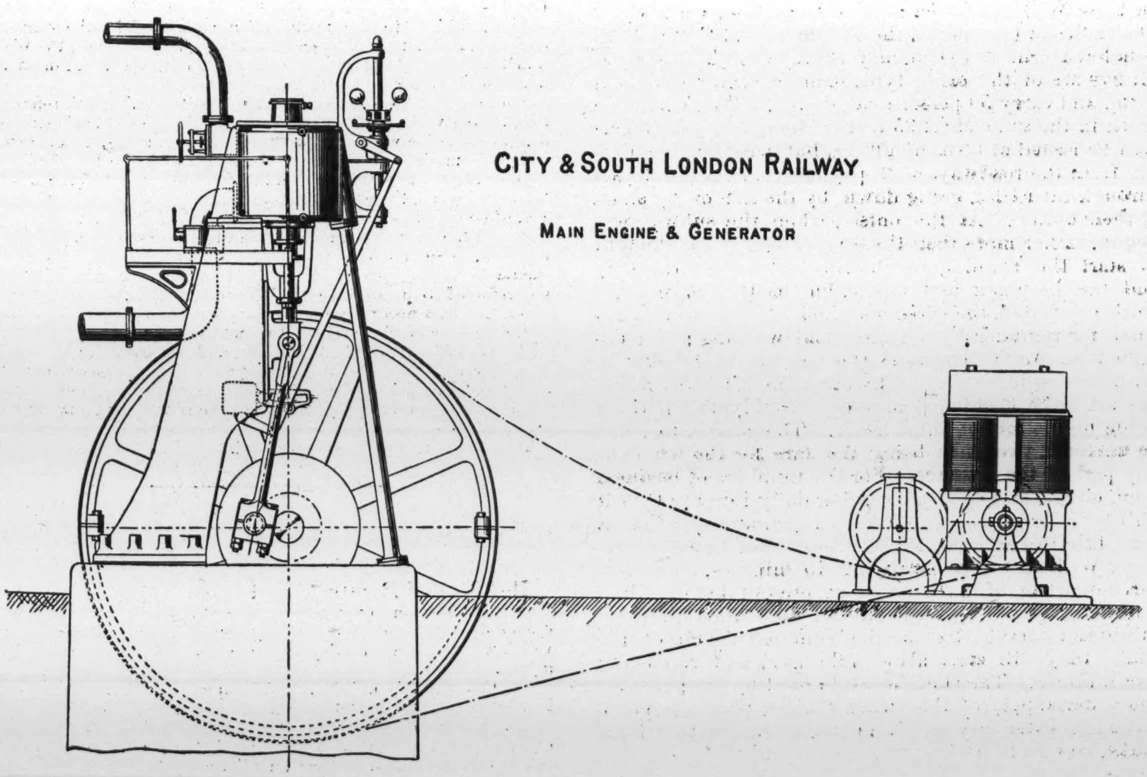
CITY & SOUTH LONDON RAILWAY

GENERAL PLAN OF GENERATING STATION



CITY & SOUTH LONDON RAILWAY

MAIN ENGINE & GENERATOR



locomotive to the rails, so completing the electrical circuit. The locomotives are fitted with a Westinghouse automatic air brake and also a screw hand brake, and they are lighted from the working conductor. The train, when loaded, will weigh 30 tons, and it is intended that ten trains shall be worked on the line at one time.

A train consists of an electric locomotive and three passenger carriages 32 feet in length from end to end of the footboard. The long passenger carriages are pivoted on two four-wheeled bogies; and the interior, which is divided by a door in the centre, contains seating for 34 persons. The enclosed portion is 28 feet in length, the external overhang of the carriage platform being coupled up to the similar overhang of the adjoining carriage, and thus forming two open platforms between the three carriages. Upon each of these a guard travels with the train. These guards' platforms are protected at the sides by iron lattice sliding doors. The carriages are lighted by electric light, the current for the lamps being, in like manner, taken off from the conductor.

Each train carries its own reservoir of compressed air, sufficient for 40 stoppages, and as it arrives at the depôt station of the line, recharges its air supply. The trains are also fitted with hand brakes, the stopping power being thus completely independent of the motive power. Block signalling has been adopted. Should, by any failure of the engine at the depôt, or any other cause, the train be brought to a standstill, passengers could leave the tunnel safely, as a passage 2 feet wide is provided, clear of the rails, and at no point could the distance to be traversed exceed three-eighths of a mile.

In the generating house is the hydraulic machinery for supplying power to the lifts at the various stations. The cylinder of the ram is 2 feet in diameter, and the wrought iron flange-jointed pipes, which convey the water at a pressure of 1,200 lbs. on the square inch, are nearly a foot in external diameter. The engines which pump the water into them act automatically, being put in motion as the accumulator descends by loss of water at the lifts. At the end of this building is a locomotive repairing shop, with special appliances for lifting out or replacing the dynamos on the locomotives.

The arrangements along the whole line for public traffic are well advanced, but will, probably, not be completed for some weeks yet. The City terminus is in King William Street; the other stations are Great Dover Street (Borough), the Elephant and Castle, Kennington Horns and Oval, and Stockwell. The lifts at all five are of the same type, namely, semi-circular in form, and carry 50 persons at a time. Two such lifts work in the same shaft 25 feet in diameter. No tickets will be issued at booking offices, but passengers entering from the roadways will pay their money and pass through turnstiles, going down by the lift or by stairs at their option. At the outset, when the subway was begun, rather more than three years ago, it was thought to start the running of the line as between the City and the Elephant and Castle, but as the engineering work proceeded, the directors thought that section too small for remunerative commercial working; and obtained an Act to continue the subway to Stockwell, with powers to extend it to Clapham. The carriages are all alike cushioned and comfortably fitted, there being no distinction into classes. The charge, too, will be uniform, twopence being the fare for the whole or any part of the distance. For the numbers of business men, clerks, and *employés* coming daily into the City it will be a great boon to be conveyed at a speed of at least 12 miles an hour, the journey from Stockwell to King William Street occupying 15 minutes, instead of three-quarters of an hour as at present by omnibus. Ultimately, the trains will follow each other at three minutes intervals, but at the commencement of the traffic they will start about 7.30 a.m., and run every five minutes. The stations are lighted by gas; and for the water supply of the steam boilers, which is taken from the water company's mains, there are two large tanks, one of 12,000 and the other of 25,000 gallons, as a reserve.

LONDON COUNTY COUNCIL.

THE ordinary weekly meeting of the council was held on Tuesday, with Sir John Lubbock in the chair.

The report of the Highways Committee stated that the committee have considered an application by Mr. H. C. Godfray, on behalf of the North Metropolitan Tramways Company, for the consent of the council to the use by the company, for a period of seven years, of electrical power on its tramways between the Swan public house, Upper Clapton, and the terminus at Moorgate Street, by way of Upper and Lower Clapton Roads, Mare Street, Hackney Road, Old Street, and City Road. Section 4 of the Company's Act of 1890 authorises the use, subject to the consent of the council as the local authority, and of the Board of Trade, of electrical power on the company's tramways or any part thereof, and the Board has power to make bye-laws for the safety of the public and the proper regulation of the traffic. The system proposed to be adopted has been for the last 12 months in operation on the company's lines in Barking Road, outside the County of London; and the committee, having fully considered the matter, are of opinion that, subject to certain conditions, the consent of the council may be given to the use of electrical power on the lines referred to in the application. They therefore recommend:—

That the council do consent to the use by the North Metropolitan Tramways Company, for a period of seven years, of electrical power on its tramways between the Swan public house, Upper Clapton, and the terminus at Moorgate Street, upon condition that previously to such use the company shall put the said lines of tramways into thorougly good condition, to the satisfaction of the council, and shall undertake to adopt such precautions as the council may from to time require to be taken for the prevention of injury to the public from the batteries and other machinery of the cars to be used on the tramways.

The Kensington and Knightsbridge Electric Lighting Company has given a notice, dated October 22nd, 1890 (registered No. 126), of an intended extension of mains in Palace Gate (1 plan). There seems to be no objection to this, and the committee recommend—

That the sanction of the council be given to the works referred to in the notice (registered No. 126), dated 22nd October, 1890, of the Kensington and Knightsbridge Electric Lighting Company.

A notice (registered No. 127), dated October 22nd, 1890, has been received from the Electricity Supply Corporation, Limited, of proposed works in the Strand and Bedford Street (1 plan); but since the date of this notice the company has intimated its intention to serve a further notice with reference to works over a larger area, and that it does not wish to proceed under the first notice. In these circumstances the committee recommend—

That the council do formally disapprove of the works referred to in the notice (registered No. 127) of the Electricity Supply Corporation, dated October 22nd, 1890.

The Westminster Electric Supply Corporation has submitted a plan of the culverts proposed to be used for the company's mains where they cross the carriage-ways. The committee are of opinion that the proposed culvert would, with a slight modification suggested by the council's engineer, be satisfactory, and they recommend—

That, subject to the modification suggested by the council's engineer, the council do approve the plan, submitted by the Westminster Electric Supply Corporation, of culverts to be used for mains where crossing the carriage-ways.

The report of the Parliamentary Committee said, with reference to overhead wires, that on the 21st October the council instructed us, in conference with the Building Act Committe, to give such notices as might be necessary to enable the council to introduce a Bill, or clauses in a Bill, to prohibit or regulate sky signs; and on the 28th instant the council passed a resolution directing that the Bill of last session relating to overhead wires, in the form in which it passed the Select Committee of the House of Commons, subject, however, to such modifications as we might consider necessary, should be again introduced into Parliament next session, and it was referred to us to give the requisite notices, and to take the other measures necessary for the purpose. We have considered as to the manner in which these two matters can best be submitted to the consideration of Parliament, and we are of opinion that they may very properly be included in the same measure, to be introduced as a private bill. We have accordingly given instructions to the agents to prepare the gazette notices and bill, and we recommend—

That the course taken be approved.

LEGAL.

Halifax and Bermuda Cable Company v. Magniac.—This was an action to recover £3,968 and interest, balance of calls due on debentures of the company applied for by the defendant, which was tried on Tuesday before Mr. Justice Charles, without a jury.

Mr. Crump, Q.C., and Mr. Spokes appeared for the plaintiffs; Mr. Haughton for the defendant.

Mr. CRUMP said defendant applied for 50 debentures of £100 each, in May, 1889, and 49 were allotted him; he paid £500 on application and another £500 on allotment, but, applications for the balance being unattended to, after some difficulty an action was commenced by substituted service, the defendant, being abroad, and judgment was signed against him. Afterwards, on the application of the defendant, the judgment was set aside, and a defence was put in to the effect that he had been induced to apply for the debentures by misrepresentation.

Mr. HAUGHTON said he need not trouble his friend to go into the case at length. The defendant had satisfied himself that the prospectus was issued *bonâ fide*, and negotiations had been going on with a view to his paying the whole amount due, and the company abandoning any claim for costs, which he understood was agreed to; but when the friend who had conducted the negotiations said he should like to have the debentures on paying over the money, it appeared that these very debentures which had been allotted to Mr. Magniac, and on the footing of which he was sued, had been deposited by the company as security for a loan, and the parties with whom they were pledged declined to release them on payment of the amount due on the calls, their claim being somewhat larger on account of interest. He asked, therefore, not making any objection to paying the amount, and even the costs, that the money might be paid into court or deposited with someone who would hand it over on receiving the debentures.

Mr. CRUMP said his friend was quite mistaken. When the defendant paid the money the debentures would be handed to him.

Mr. HAUGHTON asked leave to prove what he had stated, but

Mr. Justice CHARLES said such an issue was not raised on the pleadings. He must accept Mr. Crump's statement, and, as the only defence raised was abandoned, he must give judgment for the plaintiffs.

Edison Electric Light Company v. Robertson.—(Chancery Division.)—This was an action to restrain the defendant from further infringing the plaintiff's patents, for delivery up of the infringing lamps, and for costs.

Counsel for the plaintiffs moved for judgment in default of appearance for the defendant, and

His lordship made an order giving effect to the statement of claim.

THE BRITISH INSULATED WIRE COMPANY.

UNDER this title a company has been formed for the purpose of working in this country the patents of the Norwich Insulated Wire Company of America, by which wires are insulated with paper. Mr. R. E. Crompton is the consulting engineer, which should be a guarantee that the processes, whatever they may be, are of value. The prospectus, however, does not furnish such information as would convince an expert that a really good thing has been produced; there is not one word that would indicate that if the insulated wire were submitted to the action of damp, or if soaked in water, its insulation would remain unimpaired. We are told that in New York the wire has been submitted to *the most searching test* of being laid close to the Steam Heating Company's mains. To call this a searching test is the height of absurdity; there are plenty of cables that will stand heat. Again, the electrical inspector of the Corporation of Liverpool is convinced that the cable is a good one—because it maintains a high insulation at a high temperature. As well might it be urged that the telegraph lines in India preserve their insulation in spite of the heat of the climate. Taking several other reports, we find that practically nothing more definite is stated than that the reporter "is convinced that the cables and wires are of a very superior kind." There is apparently no attempt to make any test which the merest tyro in a submarine cable factory would know to be necessary. We do not mean to condemn the wire; it may be a very good article both as regards efficiency and cheapness, but the practice (so common) of attracting the unsuspecting public by reports which are not worth the paper they are written on, cannot be too severely condemned.

Siemens and Halske.—A Vienna correspondent, under date of October 30th, informs us that the Anglo Bank is negotiating for the taking over of the electrical establishments which the Berlin firm of Siemens and Halske owns at Vienna, as well as the electric railway at Pesth belonging to that firm.

NOTES.

Croydon and the Electric Light.—Mr. W. H. Preece, F.R.S., who has been consulted with reference to the introduction of the electric light into Croydon, which has been determined upon, has submitted an elaborate report, in which he states that it would be easy to establish a central station at the waterworks at the back of the Corporation offices, and from thence to generate and distribute sufficient electrical energy to serve the whole of the district. He proposes to replace the whole of 1,781 gas lamps by electricity. The provisional order which is to be applied for will include the whole borough; but it will only be compulsory to supply at first a fixed area, being the central portion of the town.

The Electric Light at Southampton.—The Southampton Electric Light and Power Company are now busily employed in laying their cables between the works in the Back-of-the-Walls and the Royal Southampton Yacht Club.

Theatre Lighting in Bologna.—The Brunetti Theatre, in Bologna, is now lighted by electricity. The prefectoral authorities, in order to ensure the safety of the public, informed the proprietors that they must either erect an iron curtain for the stage, or adopt the electric light, the latter alternative being eventually chosen. The plant comprises a steam engine and boiler of 14 N.H.P., and a compound Tecnomasio dynamo, running at 1,100 revolutions, with an output of 100 ampères at 100 volts. In addition to the glow lamps, the auditorium is lighted by three 10-ampère arc lamps, whilst a fourth arc is placed at the theatre entrance.

Electric Lighting of the Guildhall.—The Guildhall will be lighted by electricity for the first time on the occasion of the Lord Mayor's banquet on the 10th.

Electric Lighting at Taunton.—A gas contemporary calls attention to the fact that the electric lamps are having games. One evening last week the street arcs were out for about half an hour, and during the past two months the light has failed some half dozen times. Perhaps our electrical friends of this town may enlighten us on the subject.

Theatre Lighting.—Mr. Wilson Barrett will dispense with gas altogether behind the scenes of his new theatre, and use electric light.

The Electric Light Area in Edinburgh.—The compulsory area has been marked out, and the notices adjusted, in connection with the application for a provisional order.

Harrogate Electric Lighting.—It was decided at the last meeting of the Town Council to apply for a provisional order.

Electric Lighting in Cardiff.—The Council has decided to oppose all applications of private companies for lighting the town by electricity. It is proposed to keep it in its own hands, and land for this purpose will be purchased shortly.

Electric Lighting at Brighton.—On Tuesday, the Mayor of Brighton (Alderman Manwaring), laid the foundation stone of the Corporation electric generating station in North Road, Brighton. The Mayor expressed a hope that years to come would prove the wisdom of the decision of the Town Council. He was not prepared to say that at the first starting of the electric light installation it was going to be a financial success; but in the time to come, he thought they would find it was one of the wisest steps the Town Council had taken.

Electric Light and Diving.—On Monday last Mr. Applegarth exhibited, at 39, Queen Street, City, a greatly improved diving apparatus fitted with an incandescent lamp in the helmet. The object of the improvements is to reduce to a minimum the number of loose pieces completing the helmet, resulting in the saving of time and reduction of risk.

Electrical Engineering Corporation.—This corporation has just issued a remodelled and combined form of the catalogue hitherto published by the firms of J. G. Statter & Co., Limited, and their London agents, the United Electrical Engineering Company, Limited, owing to the interests of the two companies becoming one by the recently effected amalgamation of the two concerns The manufactures of the company cover a wide range in electrical engineering, and the catalogue will be found very complete in regard to both descriptive matter and prices.

W. T. Henley's Telegraph Works Company.—A new price list has just been brought out by this company of electric light cables, and wires in vulcanised and unvulcanised India-rubber.

Long Distance Telephony.—A long distance telephone line is to be put in operation towards the end of the year between Coblenz and Cologne. A new telephone line between Vienna and Brünn was opened on the 1st inst. The wires are of bronze, and private subscribers in Vienna are able to communicate direct with those in Brünn.

Newall High-Speed Engine.—Messrs. G. Wailes and Co. give notice that they are manufacturing the above with improvements which give remarkably increased efficiency. The engine will in future be known as the Lord-Newall high-speed engine. It is made high-pressure, compound triple expansion, quadruple, and launch.

Kingston-on-Thames Electric Lighting.—The Board of Trade will be petitioned for a provisional order by the Local Authorities.

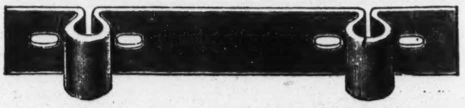
Explosion in Junction Boxes.—An accumulation of gas in a junction box in one of the principal thoroughfares in Newcastle caused an explosion last Thursday. Three or four persons were knocked down, but no one was seriously hurt.

Subways for Pipes and Mains.—A proposal has emanated from the Strand District Board to introduce a Bill into Parliament dealing with the subject of subways for electric light mains.

M. Secretan.—A financial contemporary writes:—"To have secured M. Eugene Secretan as manager is a great stroke for Elmore's French Patent Copper Depositing Company. Despite his misfortunes, M. Secretan's name is still one to conjure with, for there is no doubt that he knows copper in all its branches. But we would warn the directors and shareholders against being too greatly impressed by the fact that M. Secretan is a 'firm believer in the Elmore process,' and by his belief that 'the scope for the operations of the company is far more extensive than they had originally calculated upon.' The magnitude of his ideas is a rock on which M. Secretan has foundered before. At the same time he is a very valuable acquisition, and when the company does get seriously to work, of which there is now a prospect, no doubt he may in a practical capacity to some extent retrieve the reputation and fortunes shattered by the collapse of the last copper enterprise, in which he was 'a firm believer.'" To this we might add, that the man who was responsible for the liquidation of a Comptoir d' Escompte, ought to find his position on an Elmore Copper Company easy work.

French Elmores.—The following appeared in the *Echo* of Tuesday:—We have no doubt but that the directors of the French Elmore Copper Company are acting in the interests of their shareholders in sanctioning an issue of £50,000 of debentures in order to carry out the views of M. Secretan. It certainly appears as though this discovery as to the inadequacy of the working capital might have been made a few weeks sooner; but, be this as it may, we think the shareholders might naturally expect the board to raise the required sum at *something* under 7⅔ per cent.! The money is to be raised by the issue of £50,000 debenture stock at par, redeemable on November 1st, 1893, at 105. Thus, in addition to the high rate of interest (6 per cent.), £5 per cent. is to be paid at the end of three years, or an extra £1 13s. 4d. per annum. "Your directors have much pleasure in announcing that the patent company, Elmore's Foreign and Colonial Patent Copper Depositing Company, Limited, has offered to supply the amount required by subscribing for £50,000 six per cent. debenture stock at par, redeemable at £105 on the 1st November, 1893." In other words, the directors consider themselves lucky to be able to raise the money at the rate of £7 13s. 4d. per cent. upon a first mortgage security. Instead of "having much pleasure" in making this announcement, we should have fancied that, to pay so high a rate upon so good a security, was a subject for extreme regret. This rate, indeed, is a very serious reflection upon the security, as the opinion of no lenders can be more valuable than that of the parent company. They, more than anyone, know the nature of the security; and it is not, therefore, a compliment to it that 7⅔ per cent. is demanded. Of course there may be reasons unknown to us why the offer of the parent company should be accepted, and, provided the shareholders of the French Elmore Company are willing to pay it, no one else has a right to complain. It merely strikes us, as onlookers in the interests of the public, that if the money be required, it might be raised at something under this high rate. From the merits and prospects of the French Elmore Company, and from M. Secretan's opinions, we should have expected that even seven per cent. preference *shares* could have been issued at par, and redeemable in 1895; instead of which, *over* 7½ per cent. is being paid upon a debenture security.

New Insulating Wire Cleat. — The illustration will fully convey to our readers the novelty and utility of the new "celluvert" or kartavert fibre insulating cleat, now being introduced into this country by Messrs. David Moseley and Sons, of Ardwick, Manchester. It is largely used in America for telegraph, telephone, electric light, and electric bell *inside* wiring, and answers the purpose admirably, as it is very handy, strong, light, and cheap. Unlike other cleats or staples, it cannot be shattered by an ill-directed blow of a workman's hammer when fastening down with nails or tacks. They are made for single or double wires, but it will be seen that by cutting the double cleat across it will answer for one wire.



Semaphore Telegraphs.—In our next we shall be able to illustrate, thanks to the kindness of a friend, a semaphore telegraph, such as a correspondent in our last issue desired to see.

Provisional Orders.—The towns of Hexham and Heckmondwike are applying for orders.

Electrical Trades' Section.—A meeting of the committee will be held at Botolph House, on Monday, at 4 p.m., when various subjects will be brought forward for discussion.

Coloured Insulators.—The overhead lines of the Belgian telegraph and telephone systems follow, in a very great number of cases, unfrequented roads and by-ways where supervision is, naturally, not very close. The wilful destruction of porcelain insulators on these lines assumed such proportions that the Government has been obliged to seriously consider the question of preserving them. A special insulator, protected with a shield of galvanised cast iron, was devised, but it was found that these insulators were far too heavy, and their cost too great; they were therefore abandoned. It would seem that the brilliantly white colour of the porcelain insulators formed the chief attraction to mischievously inclined persons who, unable to resist these fatally conspicuous objects, converted the insulators into impromptu targets. Experiments were consequently made with porcelain of various colours, and a greyish-brown was finally decided upon. Several hundred insulators, coloured in this shade by means of a silicate mixed with the enamel on the surface of the porcelain, were ordered, and were set up alternately with white porcelain insulators. The results of a year's trial showed that out of 102 insulators of each kind (white and coloured) on a line of 22 kilometres in length, 25 ordinary insulators were broken, while only 13 of the coloured ones had been damaged. It was in consequence decided that wherever a white insulator was found to have been wilfully destroyed, a coloured one should be set up in its place, and should this, in its turn be broken, a metal-protected one would be substituted.

The Spanish-African Cables.—In commenting upon the failure of the first invitations to tender for the proposed cables between the Spanish settlements on the Mediterranean coast of Morocco, the *Ciencia Electrica*, of Madrid, in a recent issue, contained an article strongly condemning the Spanish Administration for its procedure. It pointed out that the conditions laid down by the Administration were utterly impracticable, and that the fact of only two tenders being received confirmed this argument, the more so since neither of the tenders complied with the stipulations of the decree. The Administration was severely blamed, in the first place, for having fixed the price to be paid for the cable at far too low a figure, and, secondly, for not having accepted one or other of the tenders, which after all did not greatly exceed the stipulated figure; nor did these offers ask for conditions at all detrimental to Spanish interests; on the contrary, the compensations asked for in other directions might actually prove advantageous to the country. The disappointment felt in Spain at the failure to secure these long desired telegraphic communications seems to have been very keen, and a perfect storm of indignation appears to have been aroused, perhaps unjustly, against the Administration.

The ss. "Silvertown."—News has been received that this cable ship passed Rio de Janeiro on November 4th and reported "all well."

Personal.—Mr. Magnus Volk having completed the fitting out of the fleet of electric launches on the river Thames, belonging to the General Electric Power and Traction Company (late Messrs. Immisch & Co.), his connection with the company has terminated, and he is now completing some new types of electrical measuring instruments which are said to possess many novel features.

The First Atlantic Cable.—Mr. F. C. Webb, of 27, Forest Road, Dalston, N.E., has published a chart which gives the longitudinal sections of H.M.S. *Agamenon* and the United States frigate *Niagara*, and the position of the coils of cable, with the lengths in nautical miles, used on the expedition of 1858, when the first Atlantic cable was laid. We understand it may be obtained from Mr. Potters, the agent for the Admiralty charts, Poultry, E.C.

The Institution of Electrical Engineers.—On Thursday, November 13th, 1890, there will be a Council meeting at 7 p.m., and an ordinary general meeting at 8 p.m., when the following paper will be read: "On the Chemistry of Secondary Cells," by Prof. W. E. Ayrton, F.R.S., Vice-President; C. G. Lamb, B.Sc.; and E. W. Smith, associates. The above paper will be discussed together with that on "The Working Efficiency of Secondary Cells," by the same authors, which was read at the Edinburgh meeting on July 16th.

More Newspaper Science.—The *Daily Telegraph*, on Tuesday, devoted a column to an article on the City and South London Railway. The following is an excellent specimen of the whole:—"Not only does Electra run on messages for us with the very speed of the obedient Puck, who at his fairy lord's command was ready and willing to 'put a girdle round about the earth in 40 minutes,' but she bravely submits to be 'accumulated' and stored up in darkness until such time as we desire light, and then we switch her on, and she leaps into the crystal vacuum and glows with cheerful splendour as she circles round the tiny film of platinum. She is not too proud to ring a bell if required, and if needs be is prepared to carry our very voices through the roar and din of the city, so that man can talk to his fellow at a distance, or minute by minute unfolds on the clicking tape the passing events of all the earth; indeed, like the German school of metaphysics, she almost fairly succeeds in abolishing time and space even as 'forms of the understanding.' Swifter than Iris, the messenger of the gods, our gentle handmaiden has never shirked any task entrusted to her; and if, perhaps, she naturally bungled a bit when set to do the ugly work of a public executioner, her growing stern sense of duty and devotion to mankind may in time steady her hand as the ultimate minister of the death-sentence. Meanwhile, it is pleasant and comforting to record that under Royal auspices she will make her *début* in London this week as an underground traveller."

Award.—A gold medal has been awarded to Messrs. Lacombe & Co. for their carbon exhibit in the French electrical section of the Edinburgh Exhibition.

St. Pancras Electric Light.—The ceremony of laying the first stone of a central station in Stanhope Street took place on Tuesday last. After the formal business Prof. Henry Robinson (the electrical engineer to the vestry) made a statement as to the work they intended to do. At Stanhope Street the central station plant would be capable of supplying low tension current to serve 10,000 incandescent lamps of 16 C.P. simultaneously, and at the same time high tension current to serve 90 10-ampère arc lamps. There would be nine low tension and two high tension dynamos, one of each serving as reserve. We understand that orders have been received for all the available current on this station. Great energy has been displayed by the vestry committee, and we heartily wish them success in their undertaking.

Ship Lighting.—Last week there was launched from the shipbuilding yard of Messrs. Barclay, Earle & Co., Limited, Whiteinch, a steel screw steamer, the *Lismore Castle*, for the Castle Mail Packet Company, Limited. She is fitted throughout with the electric light, &c.

On Tuesday the British India Company's steamer *Amra* ran her official trial on the Clyde, when a mean speed of 12·8 knots was obtained, notwithstanding that the weather was stormy. The *Amra* is fitted throughout with the electric light.

Personal.—Mr. A. W. Jones has resigned the post of Chief Electrician to the Exeter Electric Light Company, Exeter, and has joined the Laing, Wharton and Down Construction Syndicate.

Electricity in the French Navy.—A telegram from Brest states that the Minister of Marine has decided that every military port shall send to Paris two foremen and two working electricians to study the various systems of electric lighting. Lectures upon the theory and use of electricity and its employment for naval purposes will commence at the Observatory here on the 11th inst., and will be continued for four months.

A Correction.—A friend writes:—"I have just seen in the ELECTRICAL REVIEW of last week a paragraph copied from a Madrid paper, called *Los Anales de la Electricidad*, and saying that we intend to work Ferranti machines at 10,000 volts here. The machines are Ferranti's, but 2,400 volts, not 10,000, a slight difference. The underground cables are of the best Silvertown make, and the same as are being, and have been used in London for some time. I know you will be good enough just to mention the error in your next issue, as it may frighten some of our friends here if they saw it."

Vienna Telephones.—It is thought probable that the management of the Vienna telephones will be taken over by the State. The International Postal Congress will assemble at Vienna on May 20th, 1891.

The Royal Institute of British Architects.—At a meeting held at the Royal Institute of British Architects on Monday, the 3rd instant, the council room of the Institute was lit by electric light. The electric light installation is being carried out by the Planet Electrical Engineering Company, and, for the evening, a temporary connection was made with accumulators in the council room. The lighting gave satisfaction to the members of the Institute who were present.

Electricity is (Indirectly) Life!—Says the *Financial News* of yesterday:—"When the Prince of Wales opened the electric railway from the Monument to Stockwell, he may have thought that the utility of the work was limited to increasing the convenince of traffic. He was mistaken, as Sir John Fowler took the liberty of reminding His Royal Highness. So pure is to be the air in these electric tunnels, that Sir John, with his keen engineer's eye, can see a day in which doctors will send their suffering patients to the lower realms—not in the old, accustomed way, but to mend impaired health in an atmosphere more salubrious than on earth—on London earth, that is. We advance indeed. Fancy an asthma patient prescribed a course of the Inner Circle!"

The Electric Light at Barnet.—A gas contemporary says: More complaint has been made by the Barnet Local Board of the deficient lighting furnished by the electric lamps, and the contractor (Mr. Joel) has been again remonstrated with on the subject. At the last meeting of the board his reply was received, and its reading caused much amusement. He said he had ordered a number of 32 candle-power lamps for use at Barnet, but that the maker had sent 50 candle lamps instead, so that the district was actually being lighted by 32 and 50 candle-power lamps. When the mirth which this statement produced had subsided, a proposition was brought forward that the thanks of the board should be given to the contractor for his generosity. But this did not find a seconder; probably from the fact that it was regarded as sarcasm. A member asked the Clerk if his eyes had not played him false, causing him to read 50 for 15. The Clerk replied that the figure was 50. In the whole history of this extraordinary lighting undertaking, nothing has equalled this. As the local paper remarks, "The wildest dreams of the most enthusiastic resident never suggested a ray in excess of the contract light; so the Barnet Local Board may be pardoned a little surprise at the revelation."

Dangers of the Electric Light.—According to the *West Middlesex Advertiser*, the landlord and *employés* of the Markham Arms are not likely to forget the night of Monday, October 20th, 1890. The experience they then underwent, while certainly of a novel was yet of an alarming character. Late in the evening, just previous to turning out the lights, something unusual was noticed to be the matter with the electric incandescent lamps. Mr. Dew rushed to the switch and turned it off, but not before the lamps which were attached to the three large gas chandeliers in the bar were smashed to pieces, and great streaks of fire over a yard long had been streaming from the tubes, to which the platinum wire had been fastened, previous to its being broken and carried away with the globe. The box by the side of the switch was burned. Great damage was done both up and down stairs. It should be stated that at the Markham Arms is a most thorough installation of the electric light; this form of illumination being used in every part of the house. Mr. Dew, the housekeeper, and others residing on the premises, are at a loss to know the cause of the fire, and they state that if the enormous pressure of electricity had been kept up half a minute later, or if Mr. Dew had not turned the switch when he did, nothing could have saved the house from being destroyed by fire. "Three of us were standing in the bar at the time," remarked the housekeeper to our representative, "and it was an awful sight; I prefer the old gas to this, it's much safer." The electric supply at the Markham Arms was laid on by the Cadogan Electric Company, Manor Street.

Telephony in France.—According to the *Figaro*, the following towns are telephonically connected with Paris:—Lille, Rouen, Le Havre, Elbeuf, Rheims, Lyons, and Marseilles, whilst the line to Brussels is the longest. There are also connected with Paris:—Amiens-Arras-Lille, Saint Quentin, Paris-Orleans, Paris-Troyes, and it is proposed to further extend the telephone service with Epinal as the centre. There are 8,000 subscribers in Paris, 1,800 of whom have joined this year, whilst in the provinces the total is 6,000. The whole service is summed up as 22 distributing networks in Paris and district, 50 local installations, of which two are in Algiers, 20 connections with other towns, and 12 for long-distance telephony.

The "Peral."—The latest news from Spain with regard to the unfortunate *Peral*, which, after all, seems to be neither fish, flesh, fowl, nor good red herring, is to the effect that the Supreme Naval Council confirms the decision of the Technical Commission held at Cadiz; but while affirming that no new idea has been originated in the construction, and that no practical use can be made of the fabric, the Supreme Council authorises Lieut. Peral to continue his experiments on a new scheme. By this decision, the Supreme Council, says the Madrid Press, has acquired the rare distinction of having surprised the whole world.

Electricity Superseded.—Jules Verne, whose romances were at one time ridiculed, has lived to see some of them almost realised; but he will now have to take a back seat. Mr. Weems's system of electric traction, and the portelectric system, are also put in the shade by the high-sounding Mount Carmel Aeronautic Navigation Company, who propose to run air ships carrying passenger cars the size of Pullman cars. The ships will be built of aluminium, and are to travel through the air at a terrific speed. Mails will be dropped from the ships into mail bags below, as they scud through the rarefied atmosphere.

The Paris-London Telephone.—It is announced in Paris that telephonic communication between that city and London will be opened on January 1st.

The Progress of Electrical Firms.—Our contemporary *Money* devotes considerable space to the rise of Messrs. Laurance, Scott and Company, Limited. Commencing seven years ago as a private concern, electrical apparatus was manufactured in a small way. Gradually growing, and becoming limited in a company sense, the business has assumed proportions which few companies equal and fewer surpass. The dynamo room is at present full of orders, among others being an important one from the Chelsea Electricity Supply Company. Under its auspices a local company has been floated, which will doubtless supply current to the town. A central station is already supplying light to the works and the principal places around.

NEW COMPANIES REGISTERED.

Llangammarch Estate and Land Company, Limited.—Capital £100,000 in £10 shares. Objects: To acquire lands and buildings in the county of Brecon, or elsewhere, and particularly the Tyncoed Farm, parish of Llanlleonfel, and to carry on building operations. To construct, work and manage electric power, heat and light supply works, telephone and other works. Signatories (with 10 shares each): H. Watkin Lewis, Merthyr Tydvil; D. T. Alexander, Cardiff; R. A. Bowring, Penarth; C. J. Jackson, Cardiff; J. Wesley Courtes, Cardiff; Lascelles Carr, Tredelerch near Cardiff; J. E. Gunn, Cardiff; M. Tennant, Aberavon. Directors' qualification, £100 in shares or stock; the company in general meeting will determine remuneration. Registered 30th ult. by A. H. Atkins, agent for Tennant and Jones, Aberavon.

Electrical Supplies and Fittings Company, Limited.—Capital £20,000 in £5 shares. Objects: To carry on in the United Kingdom the business of electricians and mechanical engineers, and in particular to construct, purchase, sell, establish, fix and maintain all necessary motors, cables, wires, accumulators, insulators, lamps, electroliers, &c. Signatories (with one share each): J. L. A. Rooke (electrical engineer), 14, Keppel Street, W.C.; J. N. Roxburgh, 77, Queen's Road, Finsbury Park; J. Whitehead (electrical engineer), Haycot, Crouch End; F. B. Arundell, 1, Devonshire Street, Portland Place; W. L. Madgen, 3, Princes Mansions, Victoria Street; N. G. Bingham, C.E, 29, Notting Hill Terrace; G. E. Butler, 15, Park Hill, Sydenham. The signatories are to appoint the first director, qualification, £200 in share capital, remuneration £500 per annum, together with one-tenth of the net profits remaining after payment of 8 per cent. dividend on the ordinary share capital, but not to exceed £1,000 per annum. Registered 31st ult., by Wilson, Bristows & Carpmael, 1, Copthall Buildings.

United Alkali Company, Limited.— Capital, £6,000,000 in £10 shares. Objects: To manufacture chemical products and drugs of all kinds. To carry on business as metallurgists in all branches, and also as waterproofers and India-rubber and leather manufacturers. To carry on any business, or businesses, directly or indirectly connected with the generation, accumulation, distribution, supply or application of electricity. Signatories (with 1 share each), *John Brock; H. Gaskell, Widnes; J. K. Huntley, Flint; *Chas. Wigg, J. Dennis and *E. K. Muspratt, Liverpool; *A. W. Allhausen; *J. Tennant, Gateshead; *J. C. Davidson, Newcastle; *C. E. Barlow; *H. Gaskell, Jr.; *Robert Shaw, Widnes; *J. C. Stevenson, M.P., South Shields; *G. L. Wigg, Runcorn; *P. J. Worsley, Bristol; *J. A. E. Rayner, *W. J. Menzies, Widnes. The signatories and Thomas Alexander, E. Baxter and J. Gaskell are the first directors; qualification, £1,000 in shares or stock; remuneration, chairman, £2,500 per annum, with an additional £500 per annum in each year in which at least 8 per cent. is paid on the ordinary shares; the other directors will be remunerated at the rate of £400 per annum each. Registered 1st inst. by H. Forshaw and Hawkins, of 5, Castle Street, Liverpool.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

South Staffordshire Electric Lighting Company, Limited.—The annual return of this company, made up to the 30th ult., was filed on the 31st ult. The nominal capital is £100,000, in £5 shares; 139 shares are taken up, and the full amount has been called thereon. The calls paid amount to £690, and unpaid to £5.

Head, Wrightson & Co., Limited (engineers, electricians, &c.).—The statutory return of this company, made up to the 7th ult., was filed on the 18th ult. The nominal capital is £210,000, in £5 shares, the whole of which are taken up, 13,999 shares being considered as fully paid. The calls received amount to £140,005.

An extraordinary meeting of the company was held on the 23rd September, when it was resolved that the following be substituted for Clause 19 of the articles of association:—

"The directors may, subject to the regulations of these presents, from time to time make such calls upon the shareholders in respect of all moneys unpaid on their shares as they think fit, provided that 21 days' notice at least is given of each call, and that no call in respect of any share shall exceed one-fourth of the nominal amount of such share, or be made payable within two months after the last preceding call was payable, and each shareholder shall be liable to pay the amount of every call so made upon him to the persons and at the times and places appointed by the directors." This resolution was confirmed on the 8th ult., and filed 15th ult.

Dick Kerr and Company, Limited (engineers and electricians).—The statutory return of this company, made up to the 9th ult., was filed on the 17th ult. The nominal capital is £160,000, in £5 shares, the whole of which are taken up, one half being considered as fully paid. The remaining capital is also paid up.

New Electric Fire Lighter Company, Limited.—The statutory return of this company is made up to the 28th ult. The nominal capital is £10,000, in £1 shares. 602 shares are taken up, and the full amount has been called thereon. The calls paid amount to £500, and unpaid to £102.

CITY NOTES, REPORTS, MEETINGS, &c.

Westminster Electric Supply Corporation, Limited.

THE report presented at the meeting held on Wednesday states the affairs of the corporation are proceeding in a rapid and satisfactory manner.

The first work which claimed their attention, after the allotment of the shares, was that of obtaining suitable sites for central stations, three of which were required for the supply of the district which had been allotted to the corporation.

In January last the board acquired the undertaking of the City of Westminster Electrical Syndicate, Limited, who had commenced business in the district, and thereby obtained possession of St. John's Wharf, Millbank Street, and also of the contract for electric lighting in the Houses of Parliament.

After considerable trouble and delay, the board succeeded in obtaining two other eligible sites—one in Eccleston Place, Belgravia, and the other in Davies Street, Mayfair, both being on the Duke of Westminster's estate.

Pending the installation of the large central stations, current has been supplied from two temporary stations—one in the stoneyard adjacent to the Houses of Parliament and the other in Dacre Street, Victoria Street. By means of these temporary stations, the nucleus of a good business has been formed, and at the present time current is being supplied from underground mains equivalent to about 6,000 8-C.P. lamps on circuit. The demand for current already far exceeds the amount which can be generated from the plant in actual work, but the new station at St. John's Wharf is now running, and able to take over the work in the Westminster District and allow the Dacre Street plant to supply as far as Belgrave Square, pending the completion of the Eccleston Place Station.

The installations in Mayfair and Belgravia are rapidly advancing; the mains have been laid in many of the principal streets, and are being laid as quickly as possible in the others, and the Board hope that current will be supplied from both these stations early in the New Year.

The board have ordered plant (viz., engines, boilers, dynamos, batteries, &c.) to the amount of about 2,600 indicated horsepower for the three stations, a large part of which has already been delivered. This will be sufficient to supply about 40,000 8-C.P. lamps alight at one time, allowing an ample margin for steam power in reserve. According to present experience this will correspond to upwards of 100,000 8-C.P. lamps on circuit.

The system of distribution adopted is the low tension continuous current. The mains already laid are shown on maps, which can be seen at the corporation's offices, and amount in all to nearly 11 miles, and permission has already been obtained from the authorities for the whole system of proposed mains.

The financial year ends on the 31st December, and the accounts will be made up and audited to that date, and the board recommend that in future the annual general meeting of the shareholders should be held in the month of February, when the accounts would be ready for presentation.

Lord Suffield (the chairman) said great progress had been made with their works, as indicated by the maps. There had been completed nearly 11¾ miles of mains. He congratulated them on the progress made. The Millbank Street Station was in working order, and he considered they were greatly indebted to their chief engineer (Prof. Kennedy), who had shown great energy in carrying out the work. The other stations were in a fair condition, excavation was proceeding at the Davies Street Station. It was satisfactory to know that all the engines and machinery were ready whenever they were ready to receive it. In answer to various shareholders, he said the applications for current were very numerous, and were coming in every day. They could not, of course, supply these demands, but he hoped by the early part of the year they would supply all that would be required. When they would be able to pay a dividend he could not say. Expenses were very heavy, and it would be necessary to call up the whole of the capital shortly. With regard to the question of monopoly, in some parts of the district they were running side by side with another company, but in other parts they were alone. There would certainly be rivalry, and it was necessary that they made their system as near perfection as possible.

Mr. Scott (a shareholder) spoke in very favourable terms of the works which he had seen only recently. He recommended that a further remuneration should be given to the directors.

In reply to questions on the estimates, Prof. Kennedy said they were well within the stated sums.

The meeting terminated with a vote of thanks to the board.

Montevideo Telephone Company.

AT the meeting held on Friday last, the Chairman (Mr. Holland) said the report was not as satisfactory as they desired, and certainly not in accord with the indications held out at the last meeting, and at the meetings where they were asked to increase the capital of the company, for the purpose of multiple switchboards and other improvements. It was, however, satisfactory in the respect of profits, for, as shown in the report, it was about equal to that of last year, and this time they had passed through a period of great depression, which was felt both at Montevideo and Buenos Ayres. Although telephones in many cases were articles of necessity, they were in many others articles of luxury and convenience, and when there came a time in which it was imperative for customers to exercise economy, the tendency was to dispense with the telephones. The company had suffered a great deal in this way, and many withdrawals had resulted from the stagnant state of business in Montevideo. On the other hand, owing to the improvements which the shareholders sanctioned some time ago, they had a considerable number of new shareholders to take the place of those who had withdrawn, consequently they were financially about in the same position as last year. They had deducted from the profits small expenses for preliminary and depreciation on furniture; this would be written off in a few years. They would propose a full dividend of 6 per cent. on the preference shares, and to carry £1,000 to depreciation fund, and another £1,000 to reserve fund, because, in the present state of things, they deemed it prudent to have a substantial reserve. He continued to hope that when the wave of depression had passed, they would receive full benefit of all the money they had spent out there. As stated in the report, they had spent a considerable sum in extending wires and cables to new subscribers. Under the head of profit and loss there was an increase in the subscriptions of £891, on the other hand there was an increase in the expenditure of £1,130, owing to extra taxes which they had been called upon to pay, and also on account of extra insurance. Expenses in London were a little higher, owing to the fact that in the previous 12 months they had received a little consideration from the company, for whom they turned out of their old offices. Expenses in Montevideo amounted to 48 per cent. of their receipts; this compared very favourably with the telephone company on the other side of the river, whose expenses were 61 per cent. of the receipts. It showed that on their part there had been good management. He considered that the ordinary stock of the company would before long be very valuable property. Had there been no withdrawals and the same influx of new subscribers they could have paid their ordinary shareholders 6 per cent. In conclusion, he moved the adoption of the report and accounts.

Mr. T. D. Peters seconded, and the motion was carried unanimously.

The resolution as to the dividend was then put to the meeting and carried.

The Chairman moved, and Mr. E. F. Powers seconded, that the retiring director, Mr. Peters, be re-elected a director, which was done.

The auditors, Messrs. Gérard Van de Linde and Son, were re-elected at a remuneration of 20 guineas.

The meeting then terminated.

The West India and Panama Telegraph Company, Limited.

THE directors submit the accounts for the six months ended 30th June, 1890. The amount to credit of revenue is £52,351 2s. 4d. (against £49,985 11s. 9d. for the corresponding half-year of 1889), and the expenses have been £26,669 17s. 4d. (against £24,458 6s. 9d. for the same period in 1889), leaving a balance of £25,681 5s., which, with the balance of £516 19s. 8d. brought from last account, makes a total of £26,198 4s. 8d. Of this sum the directors have placed £1,500 to reserve, leaving an available balance of £24,698 4s. 8d., with which it is proposed to deal as follows:—

First preference shares—	£	s.	d.
Dividend, 6 months to 30th June, 6s. per share	10,368	18	0
Second preference shares—			
On account of arrears of dividend to 30th June, £3 per share	14,007	0	0
Balance to current half year's account ...	322	6	8
	£24,698	4	8

The traffic receipts for the six months show an increase of £2,779 7s., as compared with the corresponding period.

Several interruptions to the cables occurred during the half-year, and the expenses for repairs amount to £13,936 8s. 3d., being £2,900 19s. 11d. more than those for the corresponding six months.

The shareholders will remember that at the time of the last general meeting, negotiations were in progress with the Government of Barbados to lay a second cable to that colony in consideration of the continuance of the subsidy of £2,500 per annum for a period of 10 years. The necessary Act having been passed, the new cable was successfully laid between Barbados and St. Vincent in July last.

In consequence of the laying of the new lines above referred to out of the stock of cable in the West Indies, it has become necessary to replenish that stock for repairing purposes, and a contract has been entered into with Siemens Brothers and Company, Limited, for the manufacture of 215 knots of cable, which will be conveyed to the West Indies in the company's steamship, *Grappler*, which arrived in the Thames on the 21st inst.

The Danish colonies of St. Thomas and St. Croix have renewed their subsidies for a further term of five years from the 31st December last.

Western and Brazilian Telegraph Company.—The directors propose, after placing £7,500 to the renewal fund and £5,880 to the debenture redemption fund, a dividend at the rate of 4 per cent. per annum for the six months ending June 30th, last.

Middlesborough Electric Light Company.—Certificates were ready on Monday and will be exchanged for bankers receipts at the London office, Blomfield House, New Broad Street, E.C.

TRAFFIC RECEIPTS.

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts for the week ending October 31st were £5,411.

The Cuba Submarine Telegraph Company, Limited. The estimated traffic receipts for the month of October were £3,200 as compared with £2,903 in the corresponding month of last year. The receipts for the month of July, estimated at £3,150, realised £3,134.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of October show an increase of £154 as compared with the corresponding period.

The Eastern Extension, Australasia and China Telegraph Company, Limited. The receipts for the month of October, 1890, amounted to £47,117, as against £45,679 in the corresponding period, an increase of £1,438.

The Eastern Telegraph Company, Limited. The receipts for the month of October were £59,589, as against £62,981 for the same period of 1889, or a decrease of £3,392.

The Great Northern Telegraph Company, Limited. The receipts for the month of October amounted to £26,000; 1st January—31st October 1890, £232,800; corresponding months 1889, £229,200; do. 1888, £226,200.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending October 31st, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £4,235.

The West Coast of America Telegraph Company, Limited. The gross earnings for the month of October, 1890, were £5,800.

The West India and Panama Telegraph Company. The receipts for the half-month ended October 31st, are £2,910, as compared with £2,735 in the corresponding period of 1889.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (October 30).	Closing Quotation. (November 6.)	Business done during week ending November 6, 1890.	
					Highest.	Lowest.
250,000*l*	African Direct Telegraph, Ltd., 4 p. c. Deb. Regd. and to Bearer	100	99 —102	99 —102		
1,549,160*l*	Anglo-American Telegraph, Limited	Stock	48½— 49½	49 — 50	49	...
2,725,420*l*	Do. do. 6 p. c. Preferred	Stock	84½— 85½	85 — 86	85⅞	85¼
2,725,420*l*	Do. do. Deferred	Stock	13 — 13½	13¼— 13¾	$13\frac{5}{16}$	...
130,000	Brazilian Submarine Telegraph, Limited	10	11¼— 11¾	11¼— 11¾	11⅝	11⅜ xd & bonus
84,500*l*	Do. do. 5 p. c. Bonds	100	100 —102	101 —103		
75,000*l*	Do. do. 5 p. c. 2nd Series, repayable June, 1906	100	103 —107	104 —108		
63,416	Brush Electric Engineering Ordinary, Nos. 1 to 63,416	3	1¼— 1¾	1¼— 1¾		
63,416	Do. do. Preference, Nos. 1 to 63,416	2	1½— 2	1½— 2		
$7,216,000	Commercial Cable, Capital Stock	$100	102 —104	102 —104	103½	...
224,850	Consolidated Telephone Construction and Maintenance, Ltd.	14/-	½— ⅝xd	½ — ⅝xd		
20,000	Crompton & Co., Limited, 7 p. c. Pref. Shares, Nos. 1 to 20,000	Stock	5¼— 5¾	5¼— 5¾		
16,000	Cuba Telegraph, Limited	10	11½— 12	11½— 12	12	11⅞
6,000	Do. do. 10 p. c. Preference	10	17 — 18	17 — 18		
12,931	Direct Spanish Telegraph, Limited (£4 only paid)	5	3¾— 4¼	3¾— 4¼		
6,000	Do. do. 10 p. c. Preference	5	8½— 9½	8½— 9½		
60,710	Direct United States Cable, Limited, 1877	20	10¼— 10½xd	10⅛— 10⅜xd	10⅜	10⅛
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	13¾— 14	13¾— 14	14	13⅜
70,000	Do. 6 p. c. Preference	10	14¾— 15¼	14¾— 15¼	15⅛	14⅞
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. Aug., 1899	100	106 —109	106 —109		
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	103 —106 xd	103 —106	105	...
250,000	Eastern Extension, Australasia and China Telegraph, Limited	10	14 — 14¼	14 — 14¼	$14\frac{3}{16}$	14
320,000*l*	Do. 6 p. c. Debentures, repay. February, 1891	100	100 —102	100 —102		
91,800*l*	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049 3,976 to 4,326	100	102 —105	102 —105		
325,200*l*	Do. do. Bearer Nos. 1,050—3,975 and 4,327—6,400	100	102 —105	102 —105		
145,300*l*	Eastern and South African Tel., Ld., 5 p. c. Mort. Deb., 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	101 —104	101 —104		
198,200*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	100	101 —104	101 —104		
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	7½— 8	8 — 8½	8¼	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4¾— 5¼	4¾— 5¼		
70,000	Elmore's Patent Copper Depositing, Ltd., Nos. 23,001 to 70,000	2	5 — 5½	5 — 5½	$5\frac{1}{16}$	4⅞
67,385	Elmore's Wire Manufacturing, Limited, Nos. 1 to 67,385 issued at 1 pm. all paid (£1½ paid)	2	1¼— 1¾	1¾— 2¼	1⅞	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,000 ...(£3 only paid)	5	3¼— 4	2½— 3		
180,227	Globe Telegraph and Trust, Limited	10	8⅞— 9⅛	9 — $8\frac{13}{16}$	9	$8\frac{13}{16}$
180,042	Do. do. 6 p. c. Preference	10	14¾— 15	14¾— 14½	14⅞	14⅝
150,000	Great Northern Tel. Company of Copenhagen	10	15¾— 16¼	15¾— 16¼	15⅞	15¼
15,000*l*	Do. do. 5 p. c. Debs. (issue of 1881)	100	101 —104	101 —104		
230,000*l*	Do. do. do. (issue of 1883)	100	104 —107	104 —107		
9,334*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4,667 to 14,000	10	11½— 12½	11½— 12½		
5,334*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	11½— 12½	11½— 12½		
41,609	India-Rubber, Gutta-Percha and Telegraph Works, Limited	10	18½— 19½	18½— 19½		
200,000*l*	Do. do. 4½ p. c. Deb., 1896	100	100 —102 xd	100 —102		
17,000	Indo-European Telegraph, Limited	25	35 — 37 xd	35 — 37 xd	36⅛	35⅞
11,334	International Okonite, Ltd, Ordinary Nos. 22,667 to 34,000 (£7 pd.)	10	... — ...	6½— 7		
11,334	Do. do. Preference Nos. 5,667 to 17,000	10	... — ...	6½— 7		
38,348	London Platino-Brazilian Telegraph, Limited	10	6½— 7½	6½— 7½		
100,000*l*	Do. do. do. 6 p. c. Debentures	100	105 —108	105 —108		
43,900	*Metropolitan Electric Supply, Limited, Nos. 6,101 to 50,000	10	5½— 6	5 — 5½		
438,984	National Telephone, Limited, Nos. 1 to 438,984	5	4⅛— 4⅜	4⅛— 4⅜	$4\frac{5}{16}$	4⅛
15,000	Do. 6 p. c. Cum. 1st Preference	10	12 — 12½	12 — 12½	12½	...
15,000	Do. 6 p. c. Cum. 2nd Preference (£8 only paid)	10	9½— 10½	9½— 10½		
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11/- only paid)	1	⅛— ⅜	⅛— ⅜		
9,000	Reuter's, Limited	8	8¼— 8¾	8¼— 8¾	8⅜	..
209,750	South of England Telephone, Ltd., Ordinary, Nos. 1 to 2,000, 2,501 to 3,500, 93,251 to 300,000	1	⅛— ⅜	⅛— ⅜		
20,000	Do. 6 p. c. Cum. Pref., Nos. 1 to 20,000 (£3½ only paid)	5	2½— 3 xd	2½— 3 xd	$2\frac{15}{16}$	...
3,381	Submarine Cables Trust	Cert.	113 —117	113 —117		
78,949	Swan United Electric Light, Limited (£3½ only paid)	5	5 — 5½	5 — 5½	5⅜	5¼
37,350	Telegraph Construction and Maintenance, Limited	12	43 — 45	43 — 45	45	
150,000*l*	Do. do. do. 5 p. c. Bonds, red. 1894	100	100 —102	100 —102		
58,000	United River Plate Telephone, Limited	5	3 — 4	3 — 4		
146,128*l*	Do. do. 5 p. c. Debenture Stock	Stock	90 — 94	90 — 94		
3,200*l*	Do. do. 7 p. c. Debs., Nos. 1 to 1,000	100	... ...	... ...		
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	8½— 9½	8½— 9½		
290,900*l*	Do. do. do. 5 p. c. Debentures	100	98 —101	98 —101		
30,000	West Coast of America Telegraph, Limited	10	4 — 5	4 — 5	4	...
150,000*l*	Do. do. do. 8 p. c. Debs, repay. 1902	100	102 —107	102 —107		
64,174	Western and Brazilian Telegraph, Limited	15	11 — 11½	11 — 11½	11⅜	11¼
27,873	Do. do. do. 5 p. c. Cum. Preferred	7½	6¾— 7	6¾— 7	7	$6\frac{15}{16}$
27,873	Do. do. do. 5 p. c. Deferred	7½	4½— 5	4½— 5		
200,000*l*	Do. do. do. 6 p. c. Debentures "A," 1910	100	103 —106	103 —106		
250,000*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	103 —106	103 —106		
88,321	West India and Panama Telegraph, Limited	10	3 — 3¼	3 — 3¼	$3\frac{9}{16}$	3¼
34,563	Do. do. do. 6 p. c. 1st Preference	10	11½— 12	11½— 12	11¾	11⅝
4,669	Do. do. do, 6 p. c. 2nd Preference	10	14 — 15	14 — 15		
1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mort (Building) Bonds	$1,000	122 —127	120 —125 xd	122½	...
175,100	Do. do. 6 p. c. Sterling Bonds	100	99 —103	99 —103		
42,853	*Westmstr. Elec. Sup. Corp., Ord., Nos. 101 to 42,953 (£3 only paid)	5	2½ — 3	2½— 3	2¾	...

* Subject to Founders Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7⅛—7⅜.—Elmore Copper Depositing Priorities, 7 —7¼.—Elmore's French Patent Copper Depositing shares of £2 (issued at 10s. premium, 15s. paid), 2⅛—2⅜.—House-to-House Company (£5 paid), 4¾—5¼.—London Electric Supply Corporation, Ordinary (£5 paid), 2¼—2½.—Manchester Edison and Swan Company, £9 (£1 paid) 11/- —13/-.—Woodhouse & Rawson Ordinary of £5 (£2 10s. paid), 2⅛—¼.—Preference, 4⅜—4⅝.

BANK RATE OF DISCOUNT.—5 per cent. (25th September 1890).

THE ELECTRO-MAGNET.*

By Prof. SILVANUS P. THOMPSON, D.Sc., B.A., M.I.E.E.

(*Continued from page* 536.)

On examining the numbers in detail we observe that the largest number of magnetic lines forced round the bend of the iron core, through the coil c, was 24,040 (the cross section being a little over 1 square centimetre), which was when the armature was in contact. When the armature was away, the same magnetising power only evoked 9,795 lines. Further, of those 24,040, 23,660 (or 98½ per cent.) came up through the polar surfaces of contact, and of those again 21,980 (or 92½ per cent. of the whole number) passed through the armature. There was leakage, then, even when the armature was in contact, but it amounted to only 7½ per cent. Now, when the armature was moved but 1 millimetre (*i.e.*, $\frac{1}{25}$th inch) away, the presence of the air-gaps had this great effect, that the total magnetic flux was at once choked down from 24,040 to 17,220. Of that number only 10,810 (or 61 per cent.) reached the polar surfaces, and only 8,110 (or 47 per cent. of the total number) succeeded in going through the armature. The leakage in this case was 53 per cent.! With a 2 millimetre gap, the leakage was 65 per cent. when the strongest current was used. It was 68 per cent. with a 5 millimetre gap, and 80 per cent. with a 10 millimetre gap. It will further be noticed that whilst a current of 0·7 ampère sufficed to send 12,506 lines through the armature when it was in contact, a current 8 times as strong could only succeed in sending 8,110 lines when the armature was distant by a single millimetre.

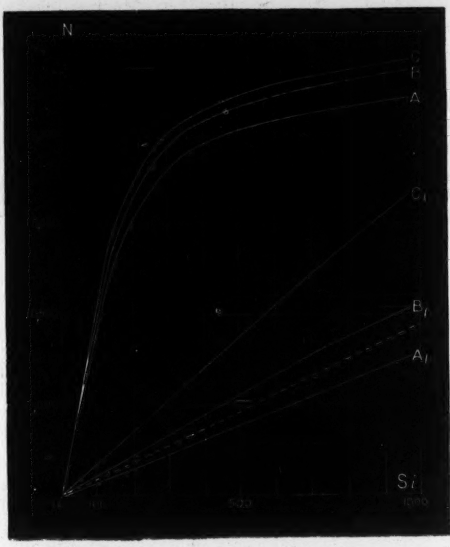


FIG. 44.—CURVES OF MAGNETISATION PLOTTED FROM PRECEDING.

Such an enormous diminution in the magnetic flux through the armature consequent upon the increased reluctance and increased leakage occasioned by the presence of the air-gaps, proves how great is the reluctance offered by air, and how essential it is to have some practical rules for calculating reluctances and estimating leakages to guide us in designing electro-magnets to do any given duty.

The calculation of magnetic reluctances of definite portions of a given material are now comparatively easy, and, thanks to the formulæ of Professor Forbes, it is now possible in certain cases to estimate leakages. Of these methods of calculation an abstract will be given in the appendix to this lecture. I have, however, found Forbes's rules, which were intended to aid the design of dynamo machines, not very convenient for the common cases of electro-magnets, and have therefore cast about to discover some more apposite mode of calculation. To predetermine the probable percentage of leakage one must first distinguish between those magnetic lines which go usefully through the armature (and help to pull it) and those which go astray through the surrounding air and are wasted so far as any pull is concerned. Having set up this distinction, one then needs to know the relative magnetic conductance, or *permeance*, along the path of the useful lines and that along the innumerable paths of the wasted lines of the stray field. For (as every electrician accustomed to the problems of shunt circuits will recognise) the quantity of lines that go respectively along the useful and wasteful paths will be directly proportional to the conductances (or permeances) along those paths, or will be inversely proportional to the respective resistances along those paths. It is customary in electro-magnetic calculations to employ a certain coefficient of allowance for leakage, the symbol of which is v, such that when we know the number of magnetic lines that are wanted to go through the armature we must allow for v times as many in the magnet core. Now, if u represents permeance along the useful path, and w the permeance of all the waste paths along the stray field, the total flux will be the useful flux as $u + w$ is to u. Hence the coefficient of allowance for leakage v, is equal to $u + w$ divided by u. The only real difficulty is to calculate u and w. In general u is easily calculated, it is the reciprocal of the sum of all the magnetic reluctances along the useful path from pole to pole. In the case of the electro-magnet used in the experiments last described, the magnetic reluctances along the useful path are three in number, that of the iron of the armature, and those of the two air-gaps. The following formula is applicable,

$$\text{reluctance} = \frac{l_1}{A_1 \mu_1} + \frac{2\, l_2}{A_2},$$

if the data are specified in centimetre measure; the suffixes 1 and 2 relating respectively to the iron and to the air. If the data are specified in inch measures the formula becomes

$$\text{reluctance} = 0{\cdot}3132 \left\{ \frac{l''_1}{A''_1 \mu_1} + \frac{2\, l''_2}{A''_2} \right\}$$

But it is not so easy to calculate the reluctance (or its reciprocal, the permeance) for the waste lines of the stray field, because the paths of the magnetic lines spread out so extraordinarily and bend round in curves from pole to pole.

Fig. 45 gives a very fair representation of the spreading of the lines of the stray field that leaks across between the two limbs of a horse-shoes electro-magnet made of round iron. And for square iron the flow is much the same, except that it is concentrated a little by the corners of the metal. Forbes's rules do not help us here. We want a new mode of considering the subject.

The problems of flow, whether of heat, electricity, or of magnetism, in space of three dimensions, are not amongst the most easy of geometrical exercises. However, some of them have been worked out, and may be made applicable to our present need. Consider, for example, the electrical problem of finding the resistance which an indefinitely extended liquid (say a solution of sulphate of copper of given density) offers when acting as a conductor of electric currents flowing across between two indefinitely long parallel cylinders of copper. Fig. 45 may be regarded as representing a transverse section of such an arrangement, the sweeping curves representing lines of flow of current. In a simple case like this it is possible to find an accurate expression for the resistance (or for the conductance) of a layer or stratum of unit thickness. It depends on the diameters of the cylinders, on their distance apart, and on the specific conductivity of the medium. It is not by any means proportional to the distance between them, being, in fact, almost independent of the distance, if that is greater than twenty times the perimeter of either cylinder. Neither is it even approximately proportional to the perimeter of the cylinders except in those cases when the shortest distance between them is less than a tenth part of the perimeter of either. The resistance, for unit length of the cylinders, is, in fact, calculated out by the rather complex formula:—

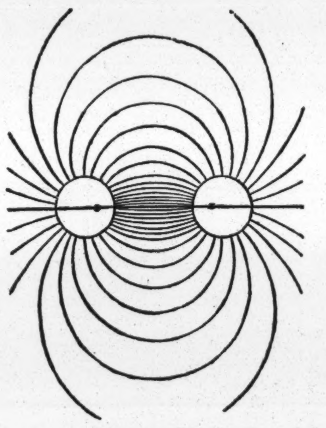


FIG. 45.—CURVES OF FLOW OF MAGNETIC LINES IN AIR FROM ONE CYLINDRICAL POLE TO ANOTHER.

$$R = \frac{1}{\pi \mu} \text{ log. nat. } h;$$

Where

$$h = \frac{2\, a}{b + 2\, a - \sqrt{b^2 + 4\, a\, b}};$$

the symbol a standing for the radius of the cylinder; b for the shortest distance separating them; μ for the permeability, or in the electric case the specific conductivity of the medium.

Now, I happened to notice, as a matter that greatly simplifies the calculation, that if we confine our attention to a transverse layer of the medium of given thickness, the resistance between the two bits of the cylinders in that layer depends on the ratio of the shortest distance separating them to their periphery, and is independent of the absolute size of the system. If you have the two cylinders an inch round, and an inch between them, then the resistance of the slab of medium (of given thickness) in which they lie will be the same as if they were a foot round and a foot apart. Now that simplifies matters very much, and thanks to my friend and former chief assistant, Dr. R. Mullineux Walmsley, who devoted himself to this troublesome calculation, I am able to give you, in tabular form, the magnetic resistances within the limits of proportion that are likely to occur.

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* Cantor Lecture. Delivered before the Society of Arts, January 27th, 1890.

The numbers from columns 1 and 2 of the following table are plotted out graphically in Fig. 46 for more convenient reference. As an example of the use of the table we will take the following :—

TABLE VIII.—MAGNETIC RELUCTANCE OF AIR BETWEEN TWO PARALLEL CYLINDRICAL LIMBS OF IRON.

$\frac{b}{p}$ Ratio of least distance apart to perimeter.	Magnetic reluctance in C.G.S. units = the magneto-motive force ÷ total magnetic flux.		Magnetic reluctance in inch units = the ampere-turns ÷ the total magnetic flux. Slab = 1 inch thick.	
	Reluctance.	Permeance.	Reluctance.	Permeance.
0·1	0·2461	4·063	0·0771	12 968
0·2	0·3404	2·938	0·1066	9·377
0·3	0·4084	2·449	0·1280	7·815
0·4	0·4628	2·161	0·1450	6·897
0·5	0·5084	1·967	0·1593	6·278
0·6	0·5479	1·825	0·1717	5 825
0·8	0·6140	1·629	0·1924	5·198
1·0	0·6681	1·497	0·2093	4 777
1·2	0·7144	1·400	0·2238	4·571
1·4	0·7550	1·324	0·2365	4·228
1·6	0·7903	1·265	0 2476	4·039
1·8	0·8220	1·217	0·2575	3·883
2·0	0·8511	1·202	6·2667	3·750
4·0	1·0500	0·952	0·3290	3·040
6·0	1·1710	0·854	0·3669	2·726
8·0	1·2624	0·792	0·3955	2·528
10·0	1·3250	0·755	6·4151	2·409

NOTE.—In the above table, unit length of cylinders is assumed (1 centimetre in columns 2 and 3; 1 inch in columns 4 and 5); the flow of magnetic lines being reckoned as in a slab of infinite extent, and of unit thickness. Symbols: p = perimeter of cylinder; b = shortest distance between cylinders. In columns 2 and 3 the unit reluctance is that of a centimetre cube of air. In columns 4 and 5 the unit reluctance is so chosen (as in the rest of these lectures wherever such measures are used), that the reduction of ampère turns to the magneto-motive force by multiplying by $4\pi \div 10$ is avoided. This will make the reluctance of the inch cube of air equal to $10 \div 4\pi \div 2·54 = 0·3132$; and its permeance as 3·1931.

EXAMPLE.—Find the magnetic reluctance and permeance between two parallel iron cores of 1 inch diameter and 9 inches long, the least distance between them being $2\frac{3}{8}$ inches. Here $b = 2·375$; $p = 3·1416$ $b \div p = 0·756$. Reference to the table shows (by interpolation) that the reluctance and permeance for unit thickness of slab are respectively 0·183 and 5·336. For 9 inches thickness they will therefore be 0·021 and 48·02 respectively.

When the permeance across between the two limbs is thus approximately calculable, the waste flux across the space is estimated by multiplying the permeance so found by the *average* value of the difference of magnetic potential between the two limbs. And this, if the yoke which unites the limbs at their lower end is of good solid iron, and if the parallel cores offer little magnetic reluctance as compared with the reluctance of the useful paths, or of that of the stray field, may be simply taken as half the ampère-turns (or, if centimetre measures are used, multiply by 1·2566).

The method here employed in estimating the reluctance of the waste field is of course only an approximation; for it assumes that the leakage takes place only in the planes of the slabs considered. As a matter of fact, there is always some leakage out of the planes of the slabs. The real reluctance is always therefore somewhat less, and the real permeance somewhat greater, than that calculated from Table VIII.

For the electro-magnets used in ordinary telegraph instruments the ratio of b to p is not usually very different from unity, so that for them the permeance across from limb to limb per inch length of core is not very far from 5·0, or nearly twice the permeance of an inch cube of air.

We are now in a position to see the reason for a curious statement of Count du Moncel which for long puzzled me. He states that he found, using distance apart of one millimetre, that the attraction of a two-pole electro-magnet for its armature was less when the armature was presented laterally than when it was placed in front of the pole-ends, in the ratio of 19 to 31. He does not specify in the passage referred to what was the shape of either the armature or the cores. If we assume that he was referring to an electro-magnet with cores of the usual sort—round iron with flat ends, presumably like fig. 11—then it is evident that the air gaps, when the armature is presented sideways to the magnet, are really greater than when the armature is presented in the usual way, owing to the cylindric curvature of the core. So, if at equal measured distance the reluctance in the circuit is greater, the magnetic flux will be less and the pull less.

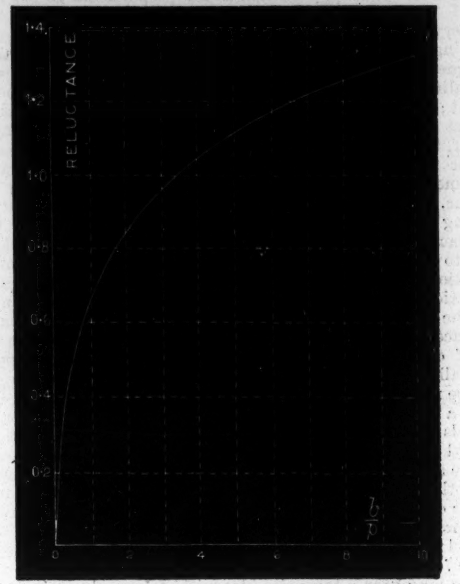


FIG. 46.—DIAGRAM OF LEAKAGE RELUCTANCES.

It ought also now to be evident why an armature made of iron of a flat rectangular section, though when in contact it sticks on tighter edgeways, is at a distance attracted more powerfully if presented flatways. The gaps, when it is presented flatways (at an equal least distance apart) offer a lesser magnetic reluctance.

Another obscure point also becomes explainable, namely, the observations by Lenz, Barlow, and others, that the greatest amount of magnetism which could be imparted to long iron bars by a given circulation of electric current was (nearly) proportional, not to the cross-sectional area of the iron, but to its surface; The explanation is this. Their magnetic circuit was a bad one, consisting of a straight rod of iron and of a return path through air. Their magnetising force was being in reality expended not so much on driving magnetic lines through iron (which is readily permeable) but on driving the magnetic lines through air (which is, as we know, much less permeable), and the reluctance of the return paths through the air is—when the distance from one to the other of the exposed end parts of the bar is great compared with its periphery—very nearly proportional to that periphery, that is to say, to the exposed surface.

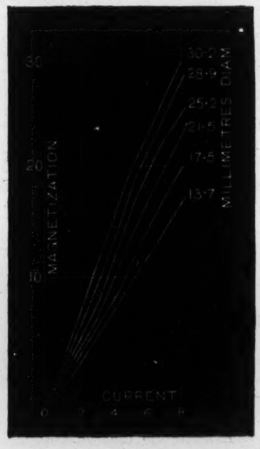


FIG. 47.—VON FEILITZSCH'S CURVES OF MAGNETISATION OF RODS OF VARIOUS DIAMETERS.

Another opinion on the same topic was that of Professor Müller, who laid down the law that for iron bars of equal length, and excited by same magnetising power, the amount of magnetism was proportional to the square root of the periphery. A vast amount of industrious scientific effort has been expended by Dub, Hankel, Von Feilitzsch, and others on the attempt to verify this "law." Not one of these experimenters seems to have had the faintest suspicion that the real thing which determined the amount of magnetic flow was not the iron but the reluctance of the return path through air. Von Feilitzsch plotted out the accompanying curves (Fig. 47), from which he drew the inference that the law of the square root of the periphery was established. The very straitness of these curves shows that in no case had the iron become so much magnetised as to show the bend that indicates approaching saturation. Air, not iron, was offering the main part of the resistance to magnetisation in the whole of these experiments. I draw from the very same curves the conclusion that the magnetisation is not proportional to the square root of the periphery, but is more nearly proportional to the periphery itself; indeed, the angles at which the different curves belonging to the different peripheries rise show that the amount of magnetism is very nearly as the surface. Observe here we are not dealing with a closed magnetic circuit where section comes into account; we are dealing with a bar in which the magnetism can only get from one end to the other by leaking all round into the air. If, therefore, the reluctance of the air path from one end of the bar to the other is proportional to the surface, we should get some curves very like these; and that is exactly what happens. If you have a solid, of a certain given geometrical form, standing out in the middle of space, the conductance which the space around it (or rather the medium filling that space), offers to the magnetic lines flowing through it, is practically proportional to the surface. It is distinctly so for similar geometrical solids, when they are relatively small as compared with the distance between them. Electricians know that the resistance of the liquid between two small spheres, or two small discs of copper immersed in a large bath of sulphate of copper, is practically independent of the distance between them, provided they are not within ten diameters, or so, of one another. In the case of a long bar we may treat the distance between the protruding ends as sufficiently great to make an approximation to this law hold good. Von Feilitzsch's bars were, however, not so long that the average value of the length of path from one end surface to the other end surface, along the magnetic lines, was infinitely great as compared with the periphery. Hence the departure from exact proportionality to the surface. His bars were 9·1 centimetres long, and the peripheries of the six were respectively 94·9, 90·7, 79·2, 67·6, 54·9, and 42·9 millimetres.

It has long been a favourite idea with telegraph engineers that a long-legged electro-magnet in some way possessed a greater "projective" power than a short-legged one; that, in brief, a long-legged magnet could attract an armature at a greater distance from its poles than could a short-legged one made with iron cores of the same section. The reason is not far to seek. To project or drive the magnetic lines across a wide intervening air-gap requires a large magnetising force on account of the great reluctance and the great leakage in such cases. And the great magnetising force cannot be got with short cores, because there is not, with short cores, a sufficient length of iron to receive all the turns of wire that are in such a case essential. The long leg is wanted simply to carry the wire necessary to provide the requisite circulation of current.

We now see how, in designing electro-magnets, the length of the iron core is really determined; it must be long enough to allow of the winding upon it of the wire which, without overheating, will carry the ampère turns of exciting current which will suffice to force the requisite number of magnetic lines (allowing for leakage) across the reluctances in the useful path. We shall come back to this matter after we have settled the mode of calculating the quantity of wire that is required.

TABLE IX.—EFFECT OF JOINTS IN WROUGHT IRON BAR (NOT COMPRESSED).

H	B				Mean thickness of equivalent air-space for one cut.		Thickness of iron of equivalent reluctance per cut.	
	Solid.	Cut in two.	In four.	In eight.	Centimetres.	Inches.	Centimetres.	Inches.
7·5	8,500	6,900	4,809	2,600	0·0036	0·0014	4	1·57
15	13,400	11,550	8,900	5,550	0·0030	0·0012	2·53	1·00
30	15,350	14,550	12,940	9,809	0·0020	0·0008	1·10	0·433
50	16,400	15,950	15,000	13,300	0·0013	0·0005	0·43	0·169
70	17,100	16,840	16,120	15,200	0·0009	0·0004	0·22	0·087

Being now in a position to calculate the additional magnetising power required for forcing magnetic lines across an air gap, we are prepared to discuss a matter that has been so far neglected, namely, the effect on the reluctance of the magnetic circuit, of joints in the iron. Horse-shoe electro-magnets are not always made of one piece of iron bent round. They are often made, like fig. 11, of two straight cores shouldered and screwed, or rivetted into a yoke. It is a matter purely for experiment to determine how far a transverse plane of section across the iron obstructs the flow of magnetic lines. Armatures, when in contact with the cores, are never in perfect contact, otherwise they would cohere without the application of any magnetising force; they are only in imperfect contact, and the joint offers a considerable magnetic reluctance. This matter has been examined by Prof. J. J. Thomson and Mr. Newall, in the Cambridge Philosophical Society's Proceedings, in 1887; and recently more fully by Prof. Ewing, whose researches are published in the *Pilosophical Magazine* for September, 1888. Ewing not only tried the effect of cutting and of facing up with true plane surfaces, but used different magnetising forces, and also applied various external pressures to the joint. For our present purpose we need not enter into the questions of external pressures, but will summarise the results which Ewing found when his bar of wrought iron was cut across by section planes, first into two pieces, then into four, then into eight. The apparent permeability of the bar was reduced at every cut.

(*To be continued.*)

NEW PATENTS—1890.

16264. "Improvements in electro-motors and dynamo-machines." H. CHITTY. Dated October 13.

16272. "Improvements in or appertaining to globe or shade holders for incandescent electric lamps, in part applicable to other lamps." R. L. B. RATHBONE. Dated October 13.

16279. "Improvements in the process and apparatus for electrical casting of metals." N. SLAWIANOFF. Dated October 13.

16322. "Improvements in insulating cells for electric batteries." S. C. C. CURRIE. Dated October 14. (*Complete.*)

16415. "Improvements in methods of and apparatus for utilising electricity in the formation of sheet metal articles." M. W. DEWEY. Dated October 15. (*Complete.*)

16472. "A new or improved automatic coin freed apparatus for giving electric shocks." B. J. STACEY. Dated October 16.

16534. "New or improved electrical priming or electrical frictional priming screw plugs." A. LONGSDON. Dated October 17. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS 1889.

13960. "Improvements in and relating to apparatus for measuring electric currents and for weighing bodies or substances." A. L. SHEPARD. Dated September 4. 8d. The operation of the apparatus is as follows:—The speed of an electro-motor is so regulated that at any moment the pull of a centrifugal governor equal to the pull of the current being measured. Any increase of the said current will cause a coil upon the extremity of a beam or balance lever to approach the coil or magnet in the said circuit, and thus lower or depress the extremity of the said beam or balance lever carrying the said coil, and consequently raise or elevate the other extremity thereof, and complete the circuit to the electromotor. The speed of the latter will then be increased so that the arms carrying the balls of the governor will fly outwards by centrifugal force, and act upon the other extremity of the said beam or balance lever, so as to draw down or depress the same, and cause the said beam or balance lever to resume its normal position of equilibrium. 6 claims.

14113. "Improvements in switches for electrical propulsion purposes." M. IMMISCH. Dated September 7. 11d. Consists in the employment of a make and break lever, which is so combined with the switches that they can only be shifted after the make and break lever has been first moved so as to break the circuit. 6 claims.

14114. "Improved switch for electrical tramcars." M. IMMISCH. Dated September 7. 11d. The switch ensures the locking of the parts for effecting the necessary changes in any position to which they have been shifted, that is to say, on one side or other of a central position, or in the central position, when the circuit is broken. 2 claims.

14447. "Improvements in or appertaining to electric or cable-propelled rail or tramway cars, and to brake mechanism therefor, partly applicable to other vehicles." W. P. THOMPSON. (A communication from abroad by S. A. Bemis and L. Pfingst, of America.) Dated September 13. 8d. Particularly relates to improved means for mounting and spring-supporting the car body on the trucks, to improvements in means for hanging the motor when used in connection with the truck, from what is termed the yoke frame, whereby it may be advantageously supported for its most efficient operation; it further relates to an improved construction of the yoke frame for the proper supporting of the brake mechanism, whereby said mechanism is independent of the car body, and will not be affected by the bounding motion thereof; it further relates to brake devices for the trucks of cars of the above-named description having such a construction and arrangement that the space between the car wheel axles of the truck which is required for the electric motor or motors, or for a grip mechanism in case the truck is used for a cable car, is not encumbered inconveniently with any of the brake-operating mechanism; the invention further relates to an improved shoe and connection for the bracing or trussing parts between the truck and the sill of the car. 9 claims.

15230. "Improvements in electric batteries." Sir WILLIAM VAVASOUR. Dated September 27. 1s. 8d. The inventor provides a porous pot, or a partially porous cell, containing or surrounding one of the electrodes of the battery; this porous pot, or partially porous cell, is closed or cemented up with the electrode therein, but having a connection with the electrode passing through, and provided with inlet or outlet passage or passages for the liquid under pressure. The other electrode or electrodes is or are placed outside the porous pot or partially porous cell. The exciting or opposing liquid is forced by pressure through the porous pot, and the invention being applicable to single or double fluid batteries. 4 claims.

15402. "Improvements in or relating to alternate current electric distribution." W. P. THOMPSON. (A communication from abroad by G. Westinghouse, jun., of Pittsburg. Dated October 1. 8d. Claims:—1. The combination with a circuit supplied by alternating electric currents, of two or more electric converters having their primary coils connected in series in said circuit, and an incandescent electric lamp or other translating device connected in the secondary circuit of each converter, the coils of the converter being so proportioned to the mass of iron in the corresponding cores that, upon the interruption of the circuit through any lamp, a normal current is allowed to pass through the other converters by reason of the high magnetic saturation of the core of the corresponding converter. 2. In a series system of secondary distribution, a converter so proportioned that the self-induction of its primary with open secondary is the equivalent of the resistance of the translating devices normally on the secondary circuit. 3. In a series system of electrical secondary distribution, converters having their primary coils so proportioned that the inductive opposition to the current is approximately the same when the secondary is open as when the secondary is closed through its normal circuit.

15449. "Improvements in electrical cables." W. T. GLOVER. Dated October 1. 6d. The inventor uses either a solid wire or strip or a strand of fine wires or strips as a conductor, and this conductor he insulates, and around this insulation he places an equivalent to the core in the shape of fine wires or strips, and he insulates these if desired. He then lays the requisite number of conductors so prepared into the cable, encasing the cable in insulating and protecting material if desired. 1 claim.

15769. "Apparatus for measuring and recording electric currents." Sir W. THOMSON. Dated October 8. 11d. Claims:—1. The instrument for measuring and recording electric currents, substantially as described and shown on the drawings. 2. In an instrument for measuring and recording electric currents by different positions of an indicator, the use of two bars attached to the indicator at right angles to one another, carrying adjustable weights for varying and adjusting the sensibility and zero of the instrument. 3. In an instrument for measuring and recording electric currents, the combination of an indicator and recorder with a cam caused to turn at a uniform speed; the recorder coming in contact with the cam once in each revolution, and remaining in contact for a longer or shorter time according to the strength of current, and recording the amount of current while in contact with the cam either by a trace on a revolving drum or by a train of counting wheel work, or by both simultaneously, substantially as described. 4. In an instrument for measuring and recording electric currents, the use of a pendulum or spring for controlling the motions of the indicator by touching it through part of its range.

15968. "Improvements in insulating supports for underground electrical conductors." W. C. JOHNSON and S. E. PHILLIPS. Dated October 10. 6d. Claims:—1. Supporting electrical conductors in underground troughs or channels by means of insulating supports having receptacles containing an insulating liquid so arranged as to effect perfect insulation between that part of the support to which the conductor is attached, and that part which is connected to the trough or channel, substantially as described. 2. The use for supporting electrical conductors in underground troughs or channels of insulating supports, constructing substantially as herein described with reference to the drawings, wherein a receptacle or cup-shaped insulator, containing an insulating liquid, is so combined with the supports for the conductors as to effectually insulate the support of the conductor from the part of the insulator connected to the trough or channel.

16599. "Improvements in and relating to electric date and time stamps." C. ADAMS-RANDALL. Dated October 21. 1s. 1d. Has for its main object the combination of number-printing apparatus with electric date and time printing apparatus. 5 claims.

16697. "Improvements in electro-dynamic machines. O. T. BLATHY. Dated October 22. 11d. Claims:—1. An electro-dynamic machine, consisting of a combined alternately acting transformer and motor, having two alternate current magnetic fields (or groups of these) separate from and independent of one another, the phases of which are displaced from one another, and of a revolving armature with coils closed upon themselves, acted upon by the two magnetic fields or groups of fields, at different parts of its surface and revolution, substantially as set forth. 2. An electro-dynamic machine, such as is referred to in claim 1, having two field magnets, or groups of these, placed at an angle to one another, and an armature with its coils straight, substantially as set forth. 3. An electro-dynamic machine, such as is referred to in claim 1, having two parallel fields, or groups of these, and an armature with its coils made in two parts, the one part at an angle to the other, substantially as set forth.

CORRESPONDENCE.

Telephone Switchboards.

In reply to your correspondent "Z." in last week's REVIEW, we should be glad to show him one of the switchboards in question in operation, and give full information at our London office, 11, Queen Victoria Street.

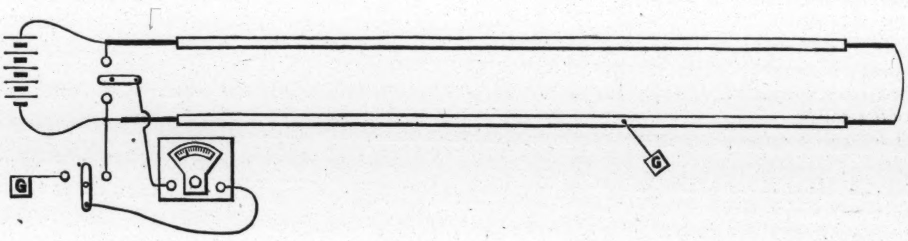
Telegraph Mfg. Co. Ltd.

November 5th, 1890.

A Speedy Method of Localising Defects in an Electric Lighting Cable.

Referring to the above article which appeared in your issue of October 10th, I submit the following, as it may contain some merit, there being less apparatus necessary.

Attach the battery to the two free ends of the cable the farther ends being connected as were shown.



With a sensitive voltmeter grounded, take the P.D of x, calling it v, then take a reading of the remaining section, calling it v′, the equation will be

$$x : 900 - x :: v : v'$$

or

$$x = \frac{(900)\ v}{v + v'}$$

A simpler method would be to take the total P.D., calling it v, then the P.D. of x calling it v′, this formula will then be

$$x = \frac{v'\ (900)}{v}$$

The above occurred to me while perusing the article, and while original with me at the moment, doubtless have been used by others with various modifications. Still hoping that they may be of use to some, I remain

Osborn P. Loomis.

Brooklyn, N.Y., U.S.A., *October 22nd*, 1890.

Rule for Electric Bell and Alarm Wiring.

In the fitting of electric bells, signals, fire and burglar alarms, &c., and more especially in repairs, renewals, or additions, it is of great importance to be able to distinguish "battery wires"—*i.e.*, wires leading direct from or to the battery—from "connecting wires," *i.e.*, wires running between pushes and indicators, indicators and bells, alarms and bells, &c.

I have devised a rule (see p. 56 "Practical Electrical Notes," 2nd Ed.: Spon), the adoption of which enables "connecting wires" to be distinguished at a glance from "battery wires," and, what is more, "+ battery wires" and "− battery wires" are clearly indicated.

My rule is as follows :—

"All wires leading from the + pole of the battery to any push, &c., should be of a plain bright colour (say white, yellow, or red); all wires running between apparatus—connecting wires—should have a covering in which two or more colours are blended; and all wires leading direct back to the battery should be of a plain dark colour, preferably black."

The adoption of this rule by electric bell fitters would, I beg to suggest, save much valuable time which is now wasted in what is generally termed "*testing.*"

W. Perren Maycock, A.M. Inst. E.E.

November 3rd, 1890.

The Elmore Copper Process.

Owing to my absence abroad, I have been unable to answer earlier the questions put by you in your leader of the 17th inst.

I wish, however, now, without troubling you or your readers with any fuller details of the Elmore process than I have given in your own and other publications, to draw attention to the following errors in your articles of the 17th and 24th inst.

1. Your calculation of the current necessary to deposit 20 tons of copper per week is practically ridiculous.

2. The resistance of "the bath," founded upon this purely imaginary current is equally ridiculous.

3. Your deduction as to the necessary size of tanks involves a like absurdity.

4. The figure of current density quoted by you from Mr. J. T. Sprague is more than double of what is possible in ordinary commercial depositing, with anything like good results.

This point is fully entered into in M. Fontaine's book from which you have quoted. The current density, therefore, which is feasible with the Elmore process being about three times that possible in ordinary work, presents an advantage of no small importance.

5. The assumption by you that the price of a horsepower is about £10 per annum—the week being 60 hours—is entirely inapplicable to the case considered by you, because—

(*a*) A week in an electro-depositing factory averages about 156 hours in place of 60 hours.

(*b*) A factory of such a kind is not set up (as suggested by you) in a city where floor space is expensive.

(*c*). In a city coal is not to be obtained delivered free at 8s. 6d. per ton as it is at present in the Elmore factory near Leeds.

(*d*.) In the case of an industry in which power forms a large proportion of the working expenses, every attention is paid to reducing the cost of the power by the use of suitable engines and power-saving apparatus.

I am only surprised that you should have dared to estimate the cost of electrical deposition on an assumption so opposed to the experience of engineers.

6. Even if the cost of power were such as you have assumed it to be, the quality of the articles produced and the small amount of labour required would still leave a very large profit to the company for depositing copper articles only, and it should be remembered that copper is only one of the metals to which the process can be applied.

I would ask you how can you reconcile the figures of cost given by you in a table on page 479, where the average cost of producing a ton of refined copper is given at about £12 with the fact that electrolytically refined copper can be bought in the open market at a price which would thus entail upon the maufacturer a dead loss of over 30 per cent. ?

The value of the various figures given by you may be fairly gauged by this sample.

If any doubt exists in the minds of yourselves or your readers on this point, a moment's enquiry of any installer of electrolytic plant will confirm the truth of my remarks.

7. You assume that the value of the Elmore wire process can only be due to the probability of it commanding a higher price.

This is entirely incorrect, and I believe that the company can show a very handsome profit in this department, even at the same price as wire of not more than 98 per cent. conductivity, which is the usual quality guaranteed and not 96 per cent. as quoted by you.

8. In opposition to your calculations we may safely put the reports of the various eminent men who have examined and tested the process, and, in addition to these (which have been published), I may add that the English calculations and results have been quite recently checked and verified with great care by competent French engineers who have visited the works at Leeds, and, after making their tests, have given a certificate as to the correctness of the cost of manufacture and the quality of the articles which you on your own responsibility, and without having seen the process, have thought well to deride.

I have selected the above eight points with a wish to make my letter as short as possible, and in justice to the Elmore Company, I trust that if I am incorrect in any of my statements, you will publicly make the same known, but if not it will only be left for your readers to conclude that you have made an unwarrantable attack upon a new industry, without such knowledge of the matter as alone could justify you in doing so.

I make no comment upon your high principled suggestion as to how persons might successfully steal the ideas of the inventors. So far as the Elmore patents are concerned, I have no doubt that the company will be perfectly ready to meet any such attempts, and to put the infringer through what you seem desirous that the patents should undergo, viz., the fire of the Court.

W. Stepney Rawson.

October 29th, 1890.

The Lane-Fox Patents.

I willingly accept the challenge to me in your last article on my patents.

Stated briefly, and stripped of all garnishments, the following are the chief arguments which you invite me to overthrow :

1. My inventions are dependent upon the working of Ohm's law. I am not the discoverer of this law ; *ergo*, there is nothing new in my inventions.

2. An arrangement of parts forming a novel combination does not constitute a patentable invention, "the parts themselves being the patentable matter, and not their rearrangement."

3. The use of secondary batteries as *reservoirs* of electrical energy does not imply or include their intermittent use (as a *reserve*), but only their constant use as a "simultaneous" accompaniment to the primary source of energy.

4. Although primary batteries are unsuitable for the maintenance of a constant potential (and therefore for electric lighting) ; yet inasmuch as the same general law governs the electric currents generated by all sources of dynamic electricity, a vague proposal for the utilisation of primary batteries for electric lighting constitutes an anticipation of my system in which they are *not* used.

I believe the mere statement of these weighty propositions, in all their naked simplicity, will carry (to most minds) their own refutation. I leave it to you to correct me if the above statement does not fairly represent your main arguments.

In order, however, to comply more literally with your request for a further *explanation,* I now offer a few more remarks on each point *seriatim.*

1. This affects the novelty of my system of distribution. Now I maintain that there is an important dif-

ference—a difference in *kind*, not merely in *degree* or in *detail*—between my system and the arrangements and projects which you and others have compared with it. The object I had in view was essentially different to that of previous electricians working in the same field. Their objects fall under two headings, namely:

(*a*) The more effective utilisation of *the* current in a circuit, from whatever source, treated as a fixed quantity by "dividing" or "subdividing" it.

(*b*) Obtaining the "maximum effect" from the generating source, as in the case of batteries, by arranging the cells for "quantity" or for "tension" as required.

My main object was to obtain *constancy of the available potential at any point irrespective of the total quantity of current flowing.*

You mentioned Werdermann as a possible anticipator of my system of distribution, but a reference to his patent No. 2,477 of 1878 shows clearly that neither did he contemplate the combination of high resistance incandescence lamps constructed of a continuous "luminous bridge," with the use of secondary batteries as reservoirs, nor had he grasped the root idea of a constant potential *with a varying load.* Indeed, according to his project—for I am not aware that it was ever tried on a practical scale—a constant potential could only be maintained by keeping up, day and night, the full current required to work the total number of lamps in the installation.[*]

2. You have here propounded quite a novel doctrine. Fortunately for the owners of a large number (if not the majority) of the most valuable patents, it has not yet been adopted by the Chancery Division, or any other Court that I know of which has jurisdiction in patent cases. But I content myself with referring you on this point to any text-book of English patent law.

3. I have never admitted that the dynamos, accumulators and lamps must *necessarily* act *simultaneously* in order to work under my system. On the contrary, I expressly state in my leading specification above referred to, that the charging and discharging of the cells may be effected at different times to suit the exigencies of an irregular and intermittent demand (see page 4 of the amended specification No. 3,988[**] of 1878). I should have thought, however, that even if I had omitted to say so, common sense would suffice to decide that the chief object of a reservoir is just the advantage of employing it when the primary source of supply fails, or is cut off.

4. My answers to the last three objections really cover this also. You say, indeed, that "it is only a question of proportioning batteries to their work," while you have already admitted that in the case of primary batteries this cannot practically be done. That is to say, no primary batteries at present known can be rendered suitable for maintaining a constant potential difference for electric lighting purposes.

With regard to the main question at present raised, namely, the novelty of my system, while I have been unable to find anything approaching an anticipation, I have been fairly astounded at the universal ignorance both of the system itself and of the principles upon which it is based, which continued to prevail up to the date of its first adoption in practice in 1882. Thus, out of a long article which appeared in the *Fortnightly Review* of February, 1879, reviewing the progress of electric lighting down to that date, Prof. Tyndall devotes about a page and a-half to the distribution of incandescent electric light according to Edison's "alleged mode," but his remarks show clearly that he had no inkling at the time of any system of general supply *with a variable load at a constant potential;* yet this was two months after my own description of my system had been published occupying over a column of the *Times*. He spoke throughout of the "well-known" law by which *the* current from a certain source may be divided and sub-divided, and compared such a "system" in the first instance, to a river dividing itself round an island or a number of islands, and reuniting itself in "*the* trunk stream;" while, in the second instance, he makes a somewhat elaborate comparison with the circulation of the blood. (The italics are mine.) Evidently, however, the learned professor had little confidence in the feasibility of this "alleged mode," for, with prescient sagacity, he concludes this part of his article as follows: "Knowing something of the intricacy of the practical problem, I should certainly prefer seeing it in Mr. Edison's hands to having it in mine."

I should be presuming too much upon your patience and courtesy were I to attempt to quote in this letter all the instances which I could adduce, between that date and 1882, of the same all-prevailing ignorance of my invention, (or let me at least say of the system of distribution, &c., I claim as my invention, and which has since that year been the most extensively adopted).

Suffice it to add that, even as late as 1881, at the Society of Telegraph Engineers, elaborate systems were propounded of maintaining constancy of light by a similar device to Werdermann's, above referred to, that is to say, by substituting equivalent *resistances* for any lamp when not in action.

Having now dealt, I think, pretty exhaustively with the various objections which you have at present made against my claim, let me add a few words from a more personal standpoint. I much regret that anything like animosity should have crept into this controversy, yet I cannot explain the attitude which the trade generally (with a few honourable exceptions) have taken up towards me and my work on any other grounds. I can understand a certain reluctance to pay me or my syndicate royalties which had not been claimed while my patents remained in other hands; it is only human nature to examine such claims very closely before "shelling out." What I do not understand is that I should be abused and ridiculed for *making* them, as if I were bound, indeed, by the previous inaction of those to whom I had assigned my rights. Surely the patentee of a system has a good right to consider himself entitled to some substantial return from it after it has been employed by nearly the whole electric lighting world? If not, a better reason should at least be given for vilifying him and spurning his claims, than any which has yet been made public.

But what I have been most pained and perplexed at in this connection is that some of those who are now most active in attacking me were actually first introduced into the electric lighting industry through me, having received their early training at my hands. *Et tu, Brute!* I might well exclaim to more than one of these; but, happily, my position is not quite so desperate as poor Cæsar's. It is some of these very individuals who are now trying to get the public to believe that I did little or nothing for the practical development of the system which I am now claiming as my own.

Fortunately, I do not depend on my later patents only for evidence to the contrary. The true history of the whole subject, and the share I had in it, remains yet to be written. One fact only in this connection I may, perhaps, be allowed now to record, and one which will no doubt take most of your readers by surprise. It is this, that the modern "E.P.S." accumulator was the outcome of my introducing Messrs. Volckmar and Philippart, jun., into this country, and the first commercially-successful storage batteries ever made over here were made with my active co-operation at the Brush Company's Portpool Lane works, of which I was the founder and manager.

---

[*] The late Sir Francis (then Colonel) Bolton, in his first *resumé* of electric lighting patents, read before the Society of Telegraph Engineers, on May 14th, 1879—that is, probably somewhat before the official publication of my leading specification—summarised Werdermann's patent after referring to his semi-incandescent lamp as follows:—"When a number of lights are joined up in parallel arc, a switch to each is provided, such that when one light is intentionally extinguished, a resistance equal to that of the light is inserted in its place, and the light in the rest of the lamps is unaltered." This, although incomplete, is a better summary than that which he gave three years and a-half later of my specification No. 3,988, out of which he only selects the *lamps* for notice.

Regretting that I am obliged to blow my own trumpet to this extent, I am, &c.,

St. G. Lane-Fox

October 4th, 1890.

At a meeting of the Defence Association, formed to resist the claims being made by the Lane-Fox Electrical Company in respect of the Lane-Fox patents, held at the offices of the Kensington and Knightsbridge Electric Lighting Company, Limited, at 148, Brompton Road, the following resolution was passed :—

"That the list of members of this association be closed on Saturday fortnight, November 22nd, and after that date, members of the electrical trade, who, being attacked by the Lane-Fox Electrical Company, are desirous of availing themselves of the benefits of this association, will be required to pay the double fee of £50." Under these circumstances, any members of the trade who wish to join the association, should communicate with me before the above-mentioned date. I may mention for the benefit of those who are not fully acquainted with the steps that have been taken in the matter, that several opinions have been obtained and submitted to counsel by different members of the association, all of which agree in advising that the claims of the Lane-Fox Electrical Company cannot be sustained. Trusting you will be able to insert this in your next issue, as it is most important that it should reach all your readers,

FOR THE DEFENCE ASSOCIATION,

R. S. Erskine, *Hon. Sec.*

November 4th, 1890.

The Electro-Deposition of Copper.

Your calculation of the current requisite to deposit 20 tons of copper in 60 hours is (of course) correct. But, for this work, even in this country, the week may be taken as 144 hours at least ; so that the current to deposit 20 tons of copper per week would thus be reduced from 287,600 to 118,800 ampères.

I may observe, with all due diffidence, that this large figure of production—over 1,000 tons of manufactured copper per annum—appears to be in excess of any probable demand at the present time, and must therefore be considered as prospective, if not as speculative or gratuitous. Why, M. Roux, at Marseille, has been contenting himself with an output of 89½ tons per annum ; whilst the great Norddentoche Affinerie produces but ten times that weight. And these firms only refine ; they do not manufacture.

In regard to the current density allowable, this depends almost entirely on the degree of purity of the anodes, upon which are dependent the character of the electrolyte and the extent of the back electromotive force. With the anodes ordinarily used in refining copper, it is not generally safe to go beyond or, indeed, so high as a density of 10 ampères per square foot of anode (or cathode) surface. At the various refineries the density actually varies from about one-fifth to twice this value. In the Elmore electro-deposition process, the anodes would probably be of comparatively very pure copper ; and the cathodes, though not plane surfaces, would, from the nature of the process, be in great measure protected against the detrimental effects ordinarily resulting from high current density. A density of over 20 ampères per square foot would no doubt in this case be practicable.

Perhaps the most important consideration in relation to the above-mentioned process, is that of the comparative size of the deposition tanks, dependent upon the resistance between the anode and cathode surfaces. It appears inevitable that this will be very considerably greater than that which obtains in the electrolytic refining of copper. In the latter process the distance between the anode and cathode surfaces, both in the form of plates, varies from about ·8 inch to 4 inches ; the most usual distance being about 2 inches. The resistance per square foot of anode varies from ·0108 to ·0322 ohm. Without being practically acquainted with the details of the Elmore process, I think I may, nevertheless, safely say that the tank resistance per square foot of anode will, in this case, be much greater, that the consecutive anode surfaces will be much farther apart ; that the cathode surface, no longer in the form of a plate, will be disproportionately small (or, in other words, the anode surface will or should be disproportionately large with a view to reduce resistance as much as possible) ; and that the tanks, for a given output, will be much larger than those in use for the electrolytic refining of copper.

On the other hand, and in conclusion, I may point out that the deposition would probably be effected under an E.M.F. considerably less than one volt. In electrolytic refining, the E.M.F. for each tank in a series varies from ·2 to ·5 volt ; the mean value being ·3 volt. In a process where the anodes would be of comparatively pure copper, the E.M.F. should be below this mean value—unless, indeed, such untoward conditions are realised that economy of horse-power becomes impracticable in view of the urgency of reducing expenditure of capital on plant.

Desmond G. FitzGerald.

Accumulator Explosions.

It has often occurred to me that the above subject has not received the attention in your columns which it probably deserves. But I have attributed the omission to the exercise of a wise discretion, seeing that the public are so prone to take alarm at every bogey which presents itself, and that in certain quarters a considerable amount of prejudice exists.

Since, however, attention has been called to the subject in a somewhat objectionable manner, perhaps the sooner the public are made acquainted with the real facts, and to what extent danger, if any, really exists, the better.

I may say that for a period extending over five or six years, during which the Great Northern Railway Company have had in use, under my charge, some hundreds of accumulators for both train and stationary lighting, only four cases of explosion have come under my notice, and these were only of a very insignificant character, the damage in each case being confined to the particular cell in question. Three were occasioned by the connecting straps becoming oxidised and breaking off inside the cell just above the surface of the liquid, through the motion of the trains and arcing across, which, of course, ignited the gases. It is needless to state that these were teak lead-lined cells, fitted with lids and vent holes.

The remedy for this seems comparatively simple. Have the connecting lugs or straps made of sufficient strength to resist all possible vibrations, and see that they are properly *burnt*, *not* tin soldered on. Also, where possible, duplicate them; finally, the connections from cell to cell should be made by a separate flexible connector, and not simply by means of a bolt through the two adjoining straps.

The fourth case was occasioned by the carelessness of a workman holding a lighted match over the cell while charging ; which, however, was against orders, as the usual practice is to use a small glow lamp, with the globe whitened or silvered on one side so as to reflect the light into the cell.

In conclusion, if proper care were exercised in the manufacture, setting up and management of accumulators, explosions would be almost impossible.

F. W. Cooke.

November 3rd, 1890.

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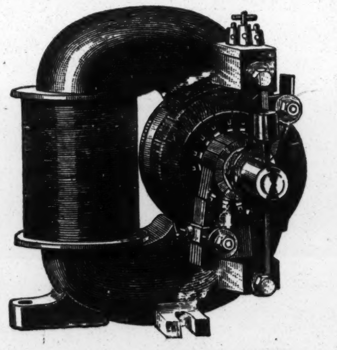

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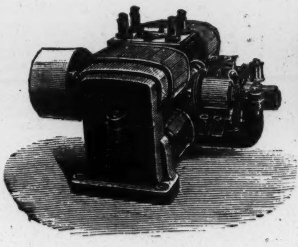

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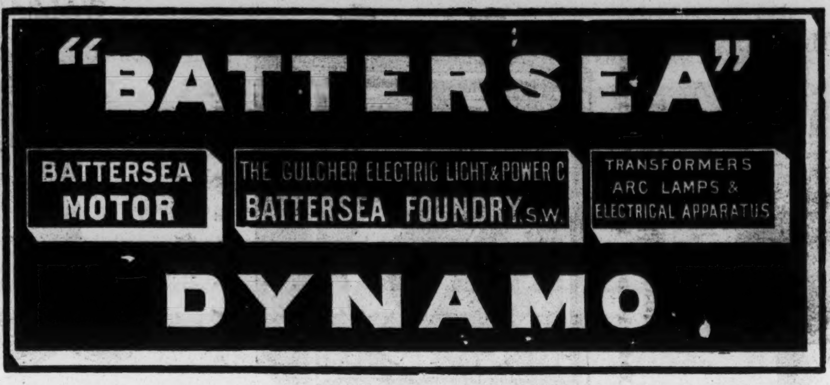

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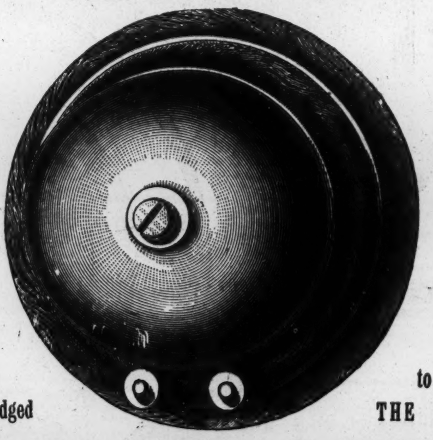

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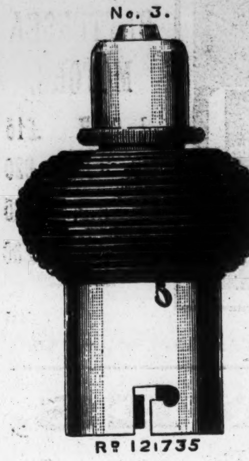

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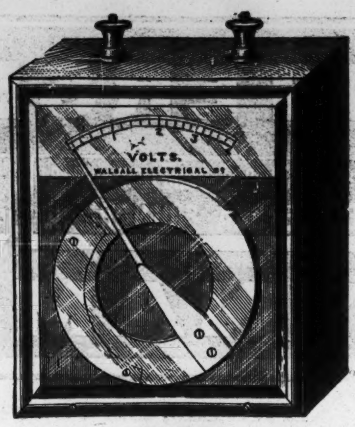

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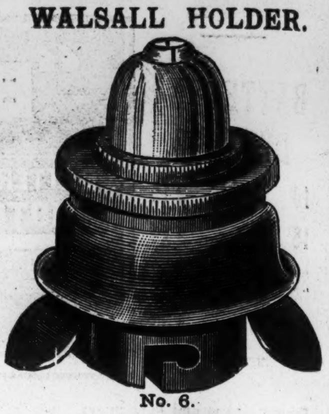

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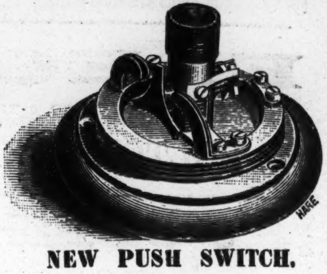

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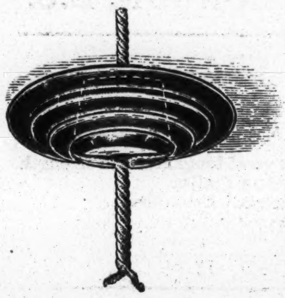

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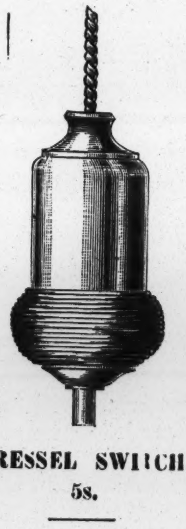

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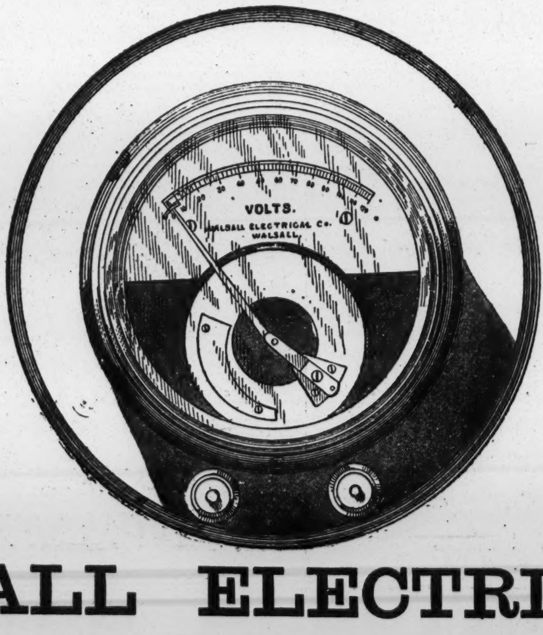

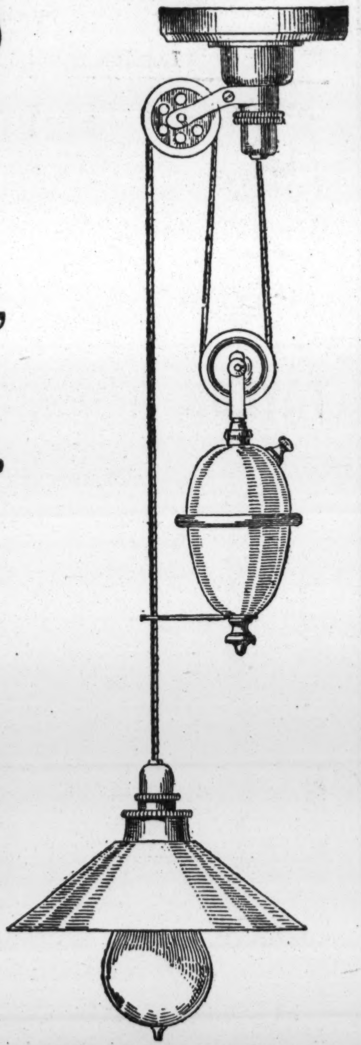

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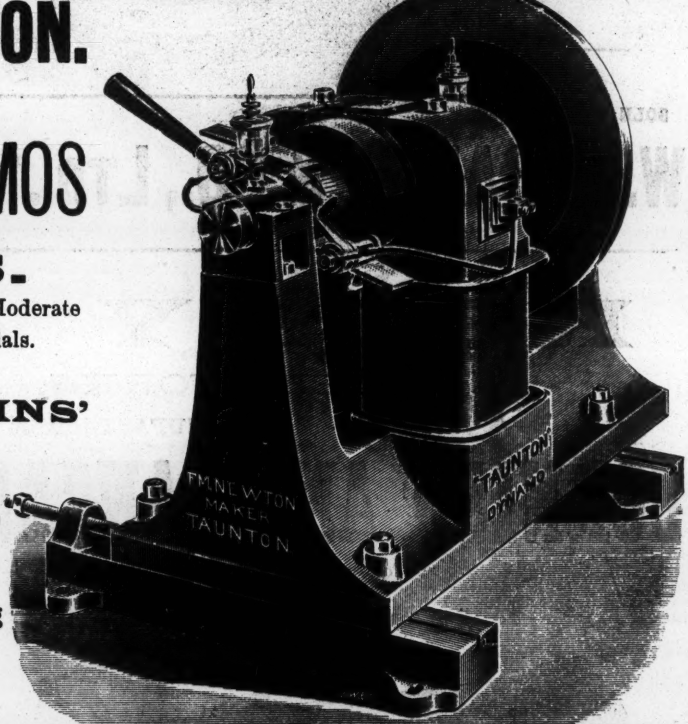

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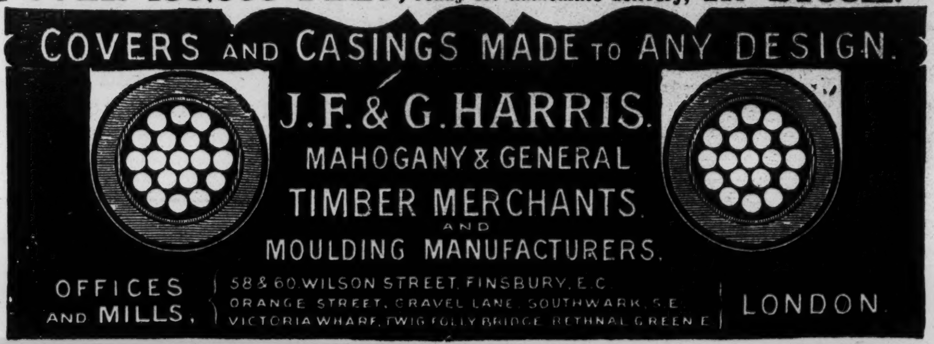

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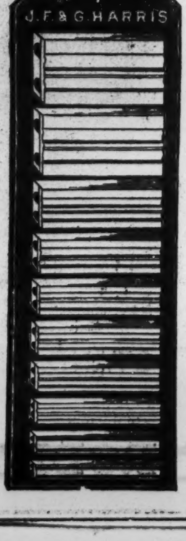

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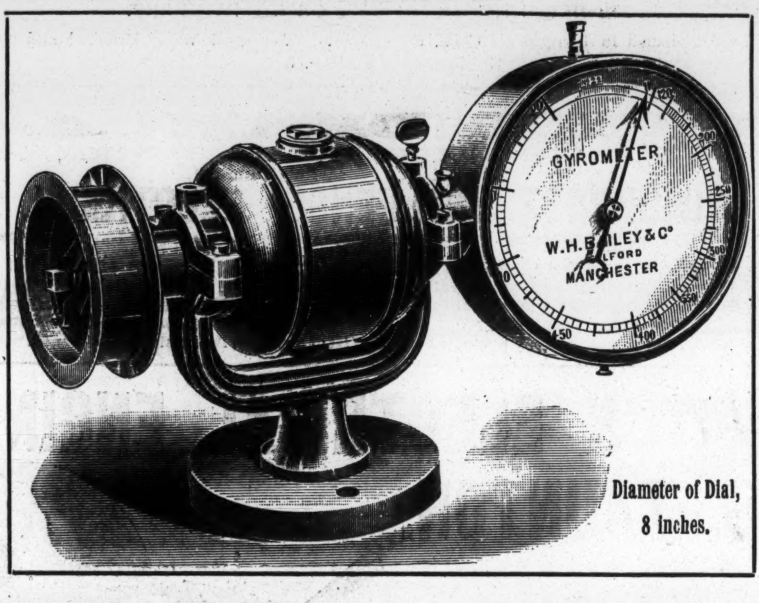

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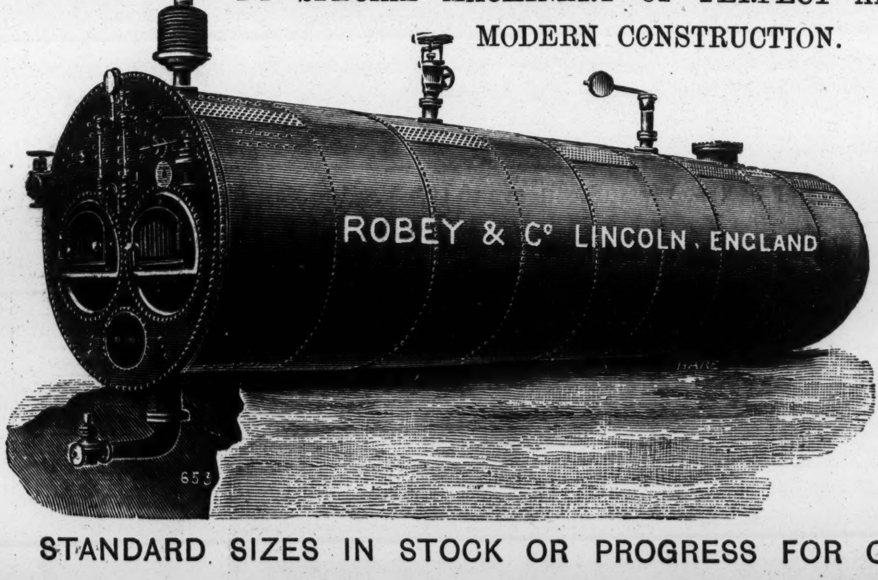

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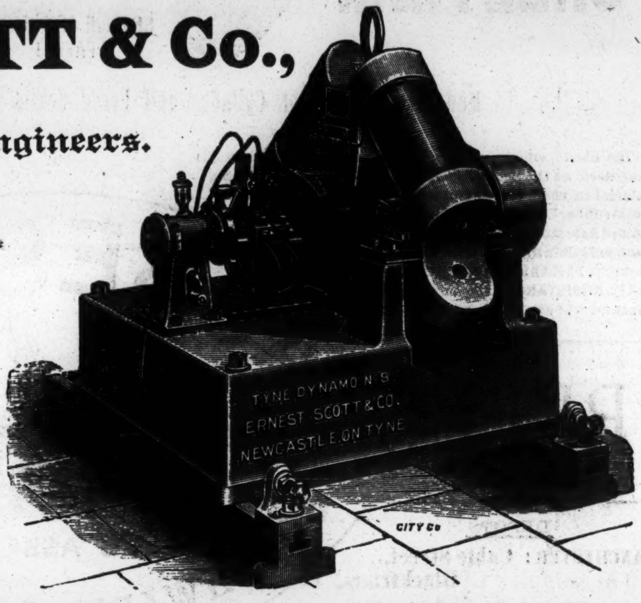

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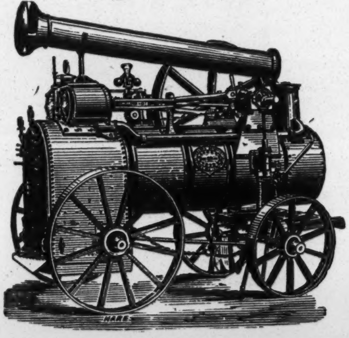

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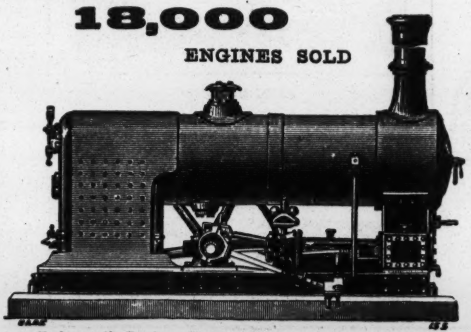

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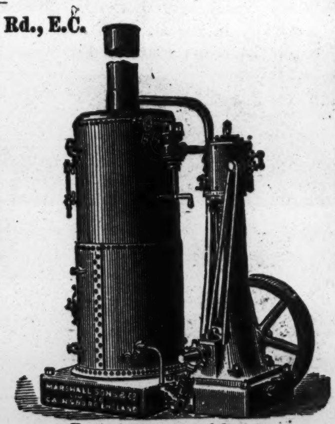

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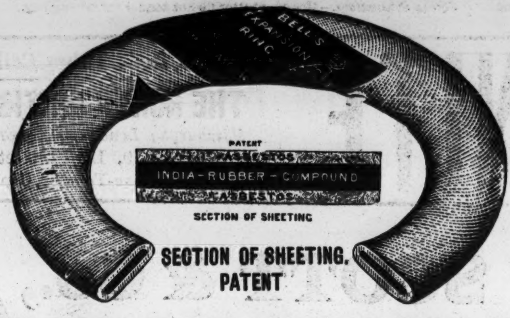

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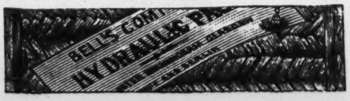

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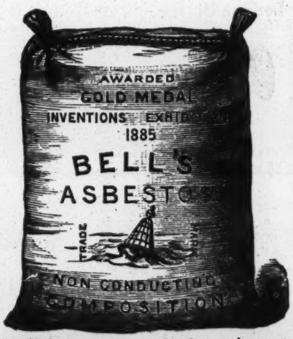
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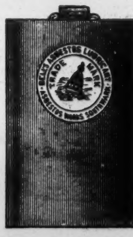

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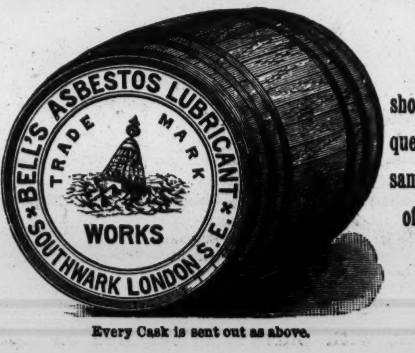

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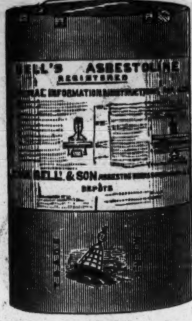

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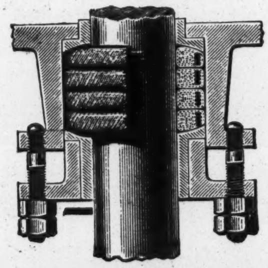

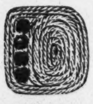

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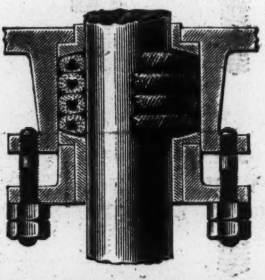

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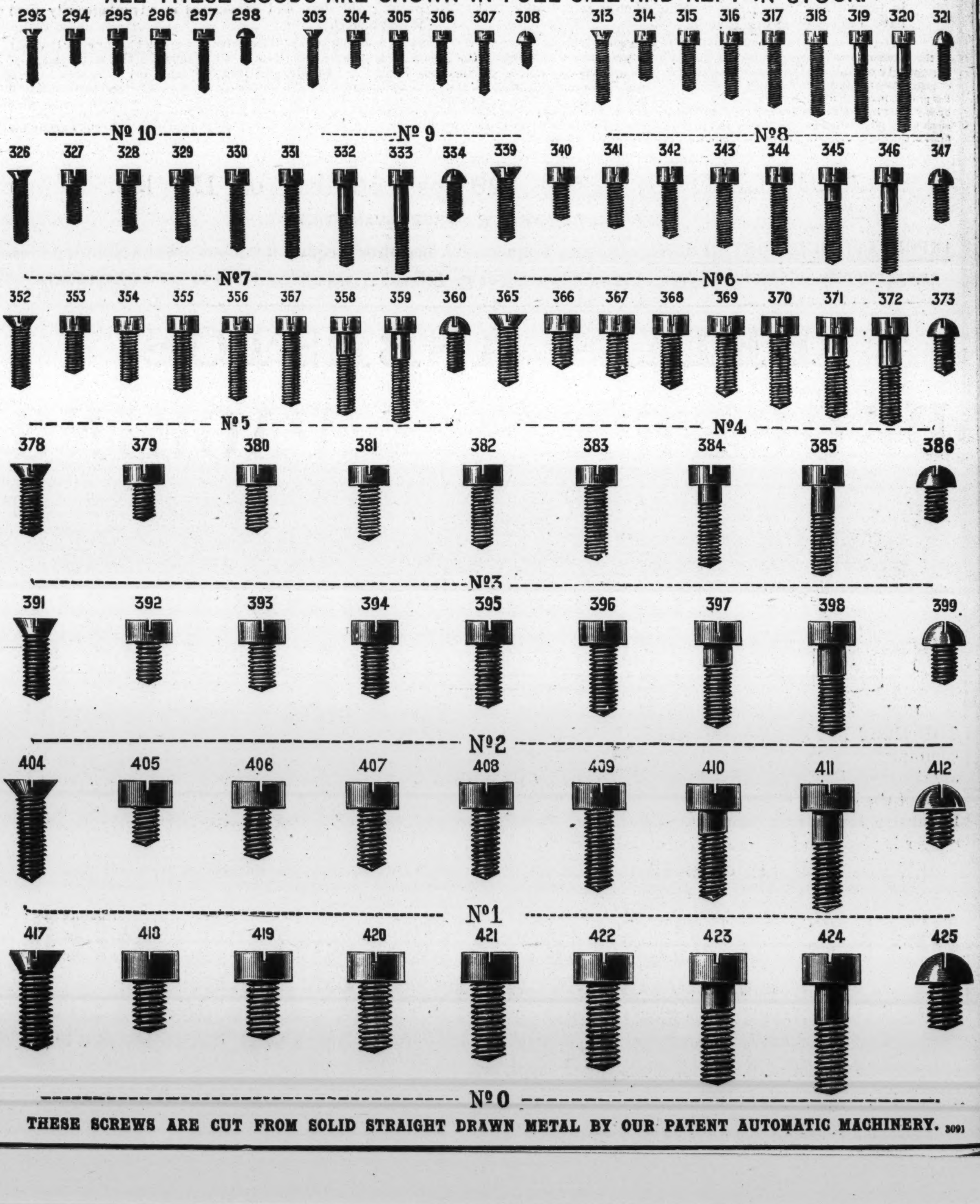

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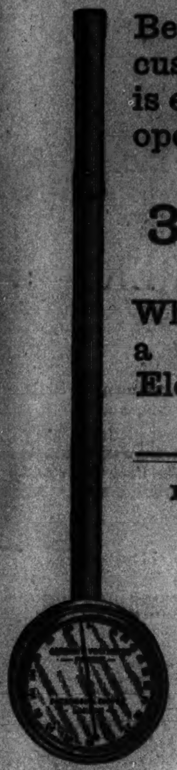

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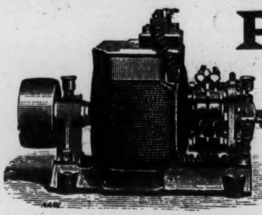

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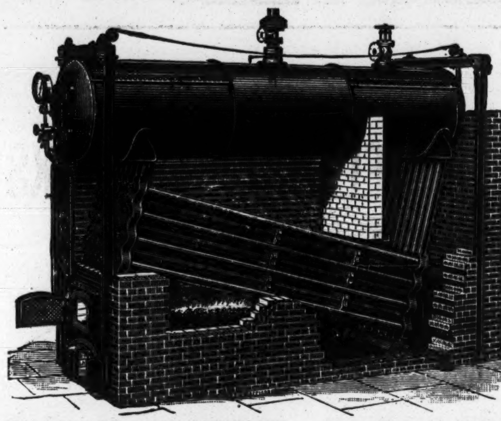

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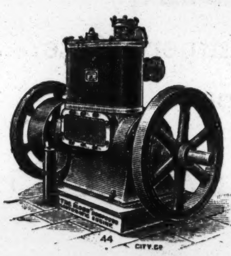

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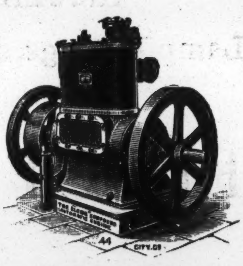

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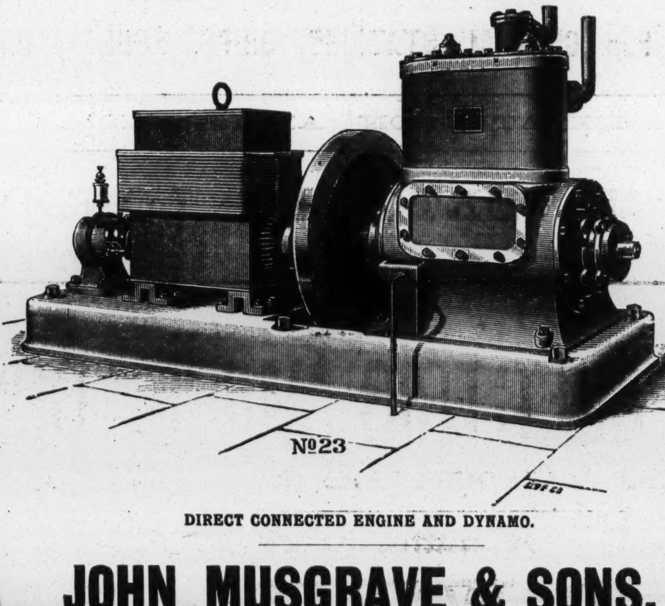

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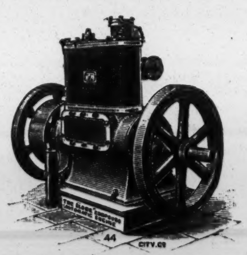

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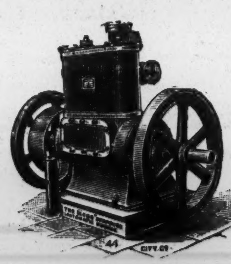

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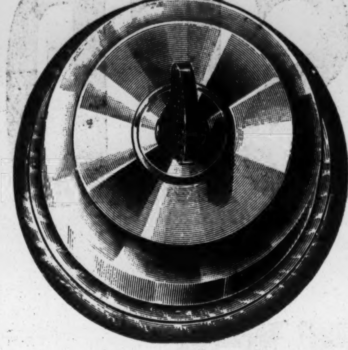

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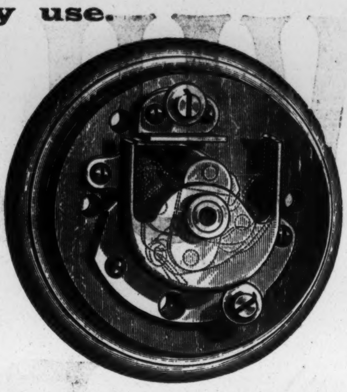

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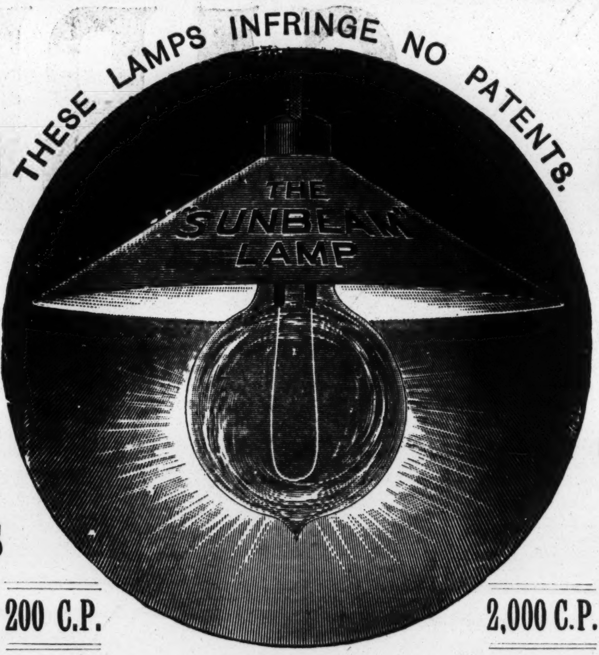
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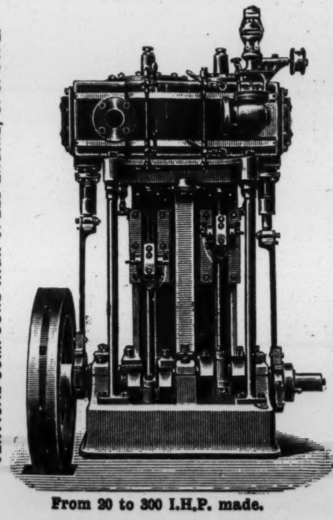

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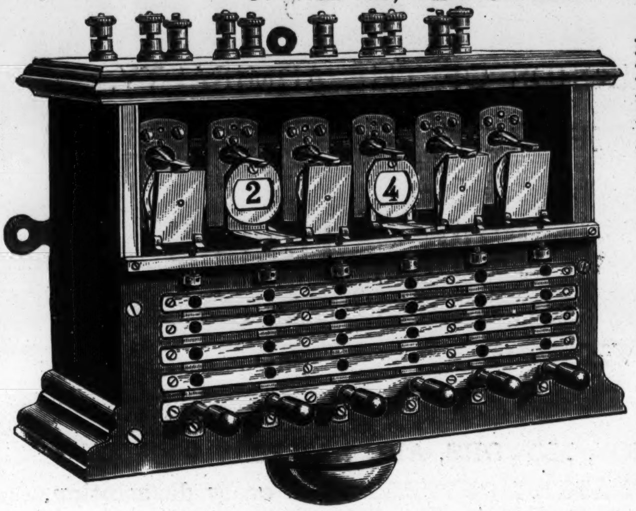

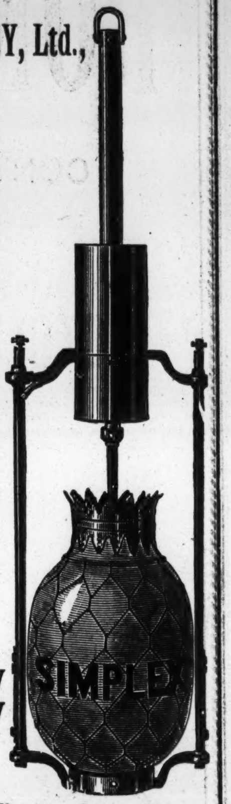

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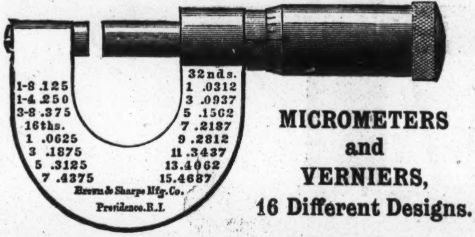

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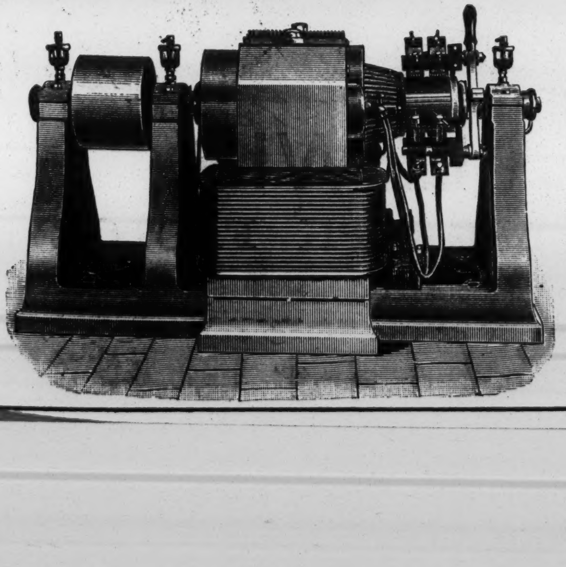

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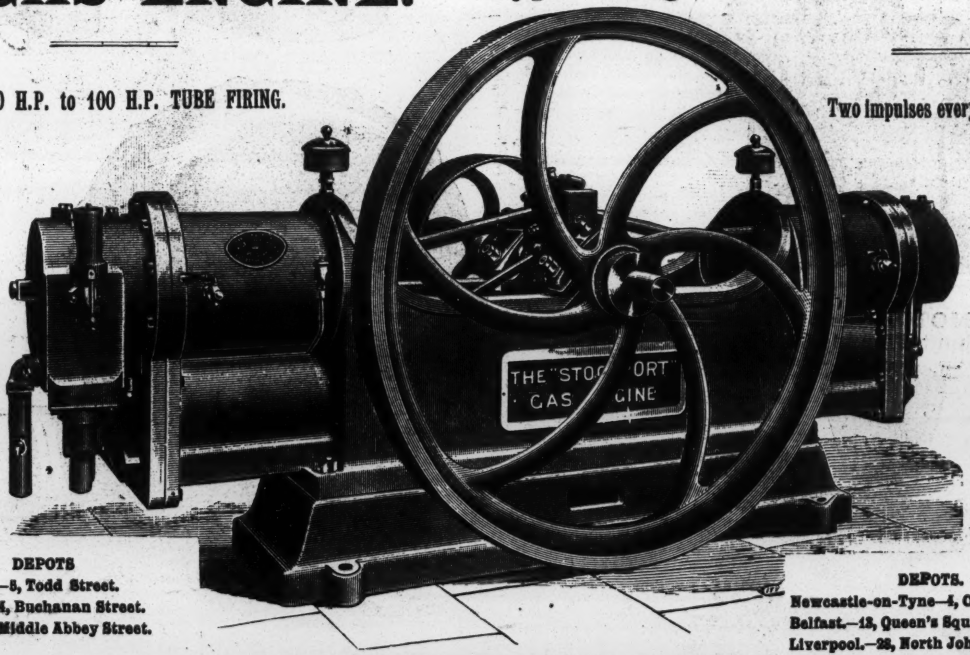

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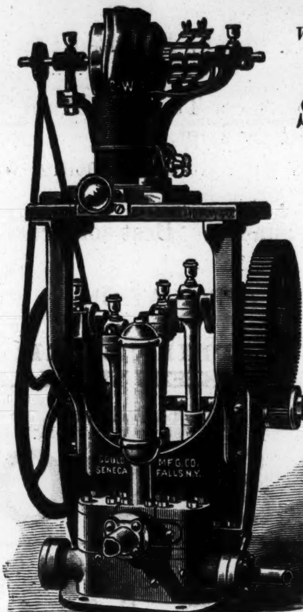

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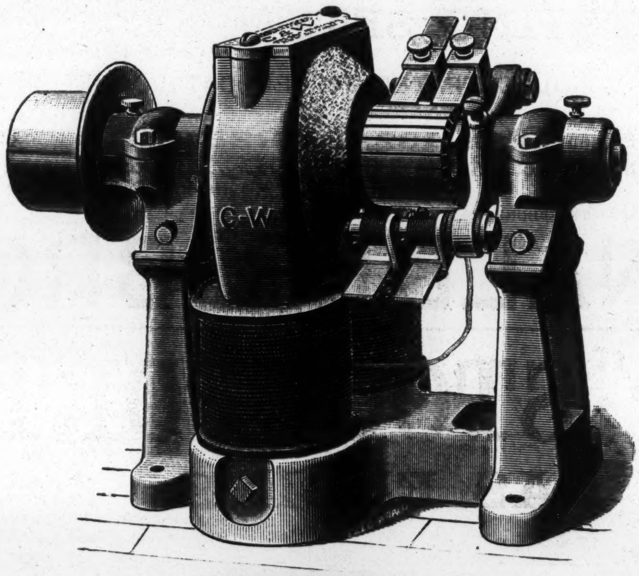

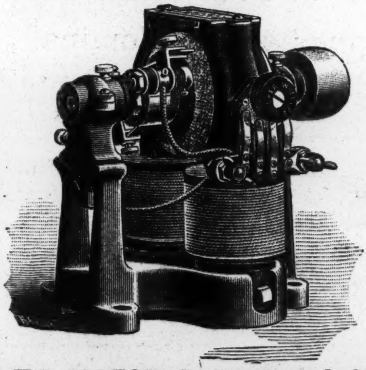

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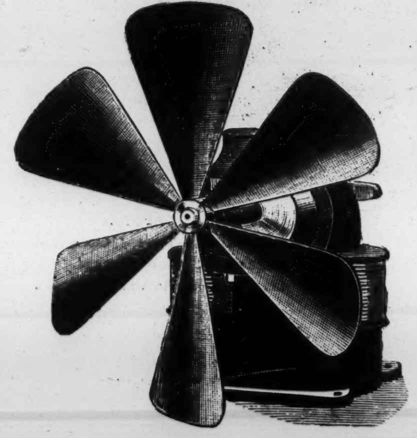

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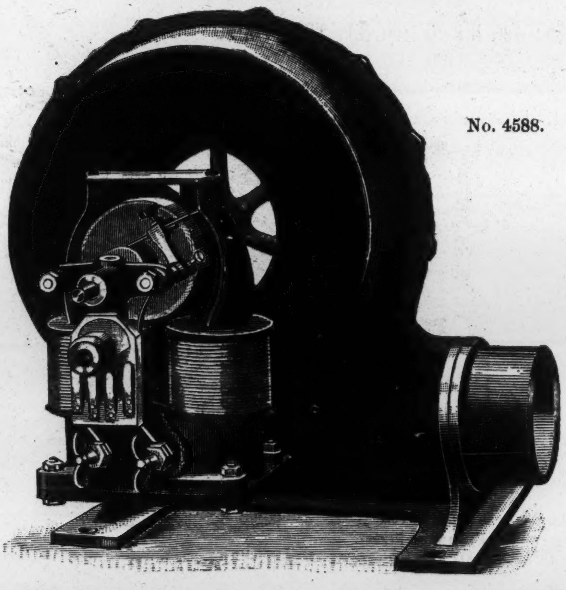

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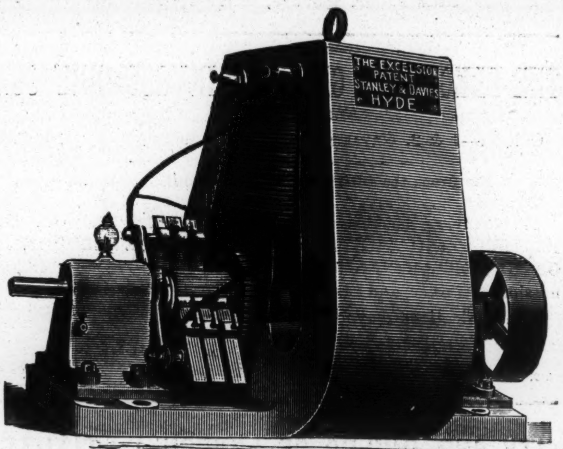

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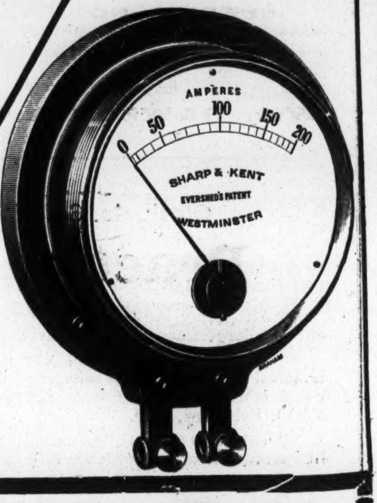

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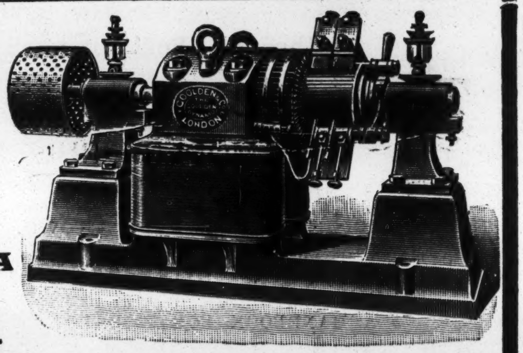

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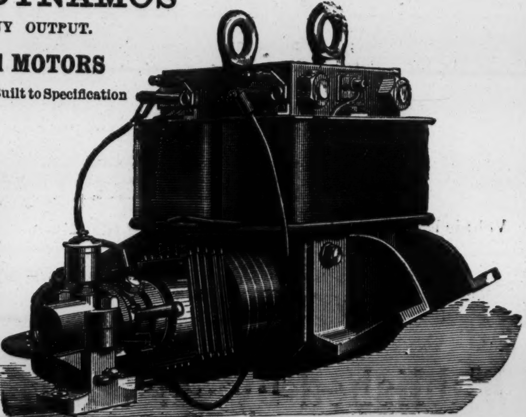

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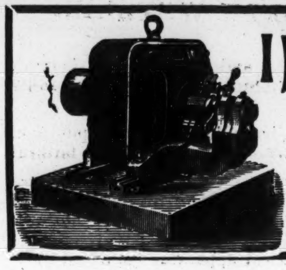

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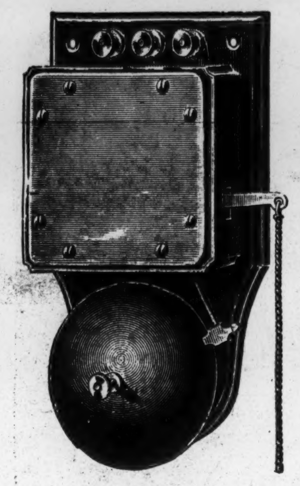

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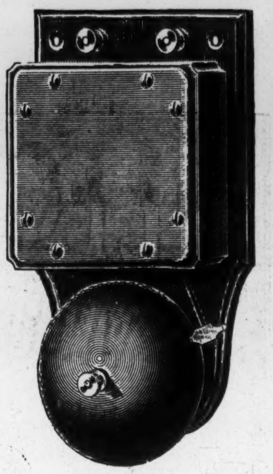

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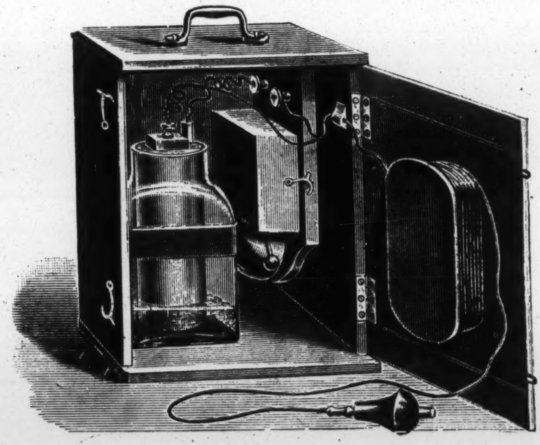

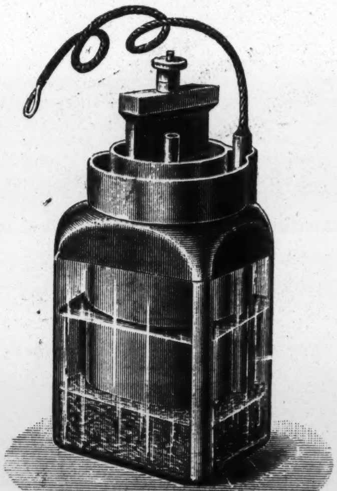

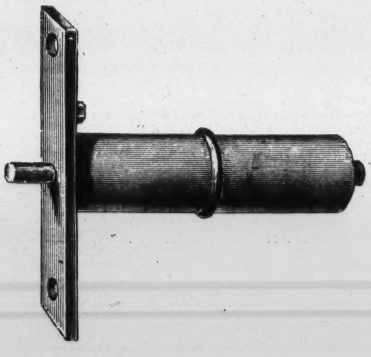

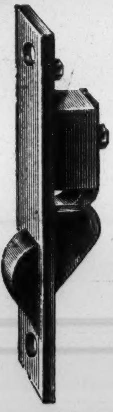

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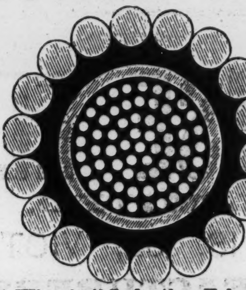

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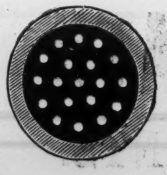

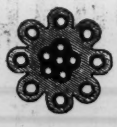

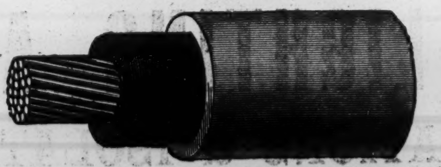

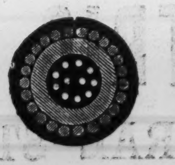

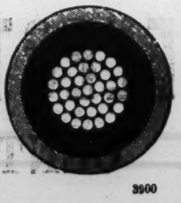

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